76-08

DUAL TRACE PLUG-IN

INSTRUCTION MANUAL

DUMONT

OSCILLOSCOPE LABORATORIES, INC.

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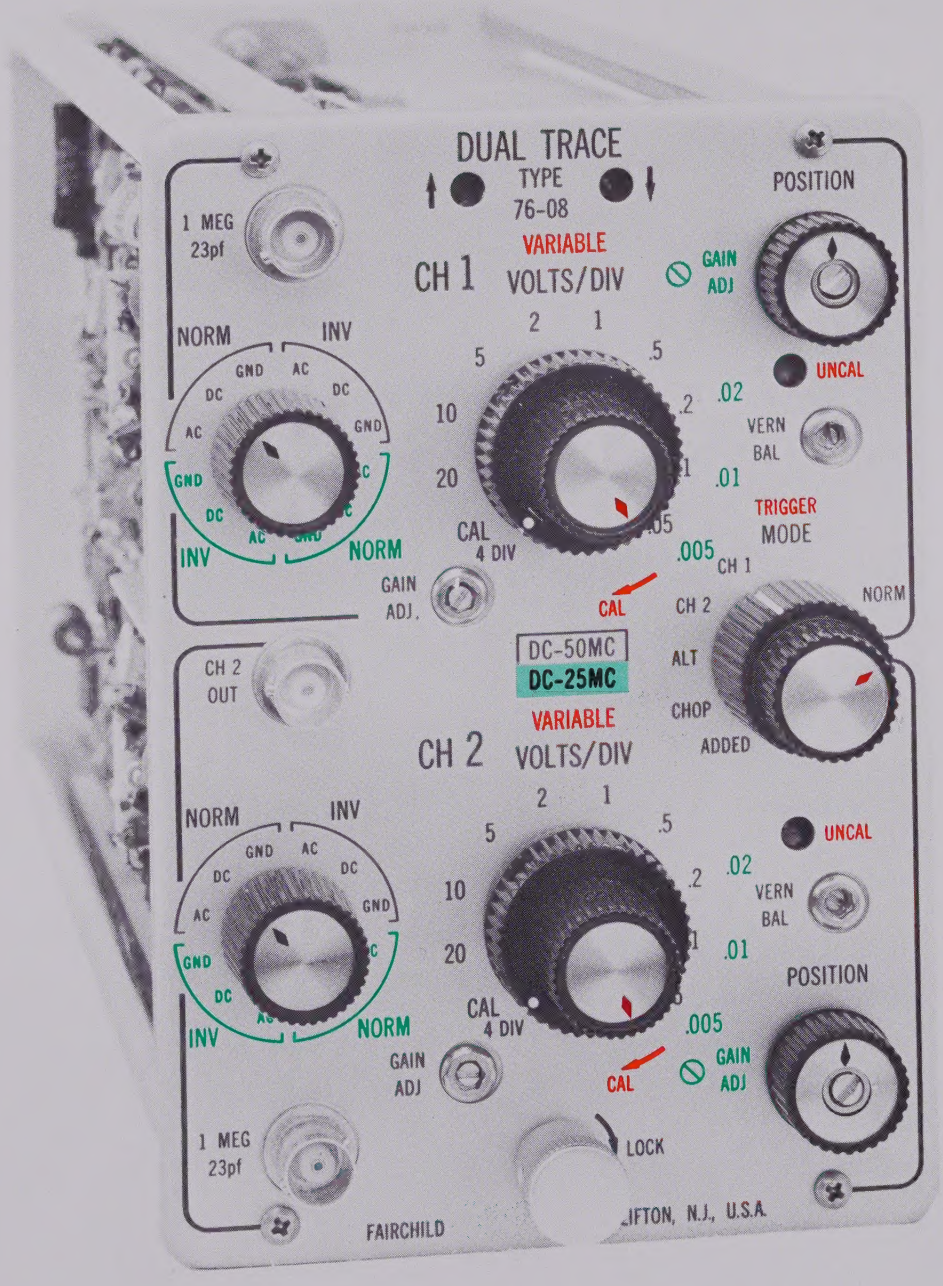


Figure 1-1. Type 76-08 Dual Trace, High Gain, Wide Band Plug-In

SECTION 1
TECHNICAL SUMMARY

1-1. INTRODUCTION

The Type 76-08 Amplifier is a dual-channel amplifier and is provided with two basic amplifier sensitivities and bandwidths for X1 and X10 calibrated operation as follows:

- 50 millivolts/division sensitivity with a dc to 50 megacycle bandwidth (X1)
- 5 millivolts/division sensitivity with a dc to 25 megacycle bandwidth (X10)

Operation of this plug-in unit enables the user to obtain two vertical signals on the screen simultaneously or to display either channel individually.

The VARIABLE gain control, located concentrically with the VOLTS/DIV switch, has a range of greater than 1:2½. This VARIABLE gain control provides continuous overlap between steps of the attenuator (VOLTS/DIV) switch. A detented stop position is provided when the VARIABLE gain control is set to CAL.

A MODE switch is provided which enables the selection of either Channel 1 or Channel 2 for separate display or the combination of both channels for dual display. In addition, ALTernate or CHOPped modes of operation are available. Use of the polarity inversion switch may give Channel 1 minus Channel 2 or Channel 2 minus Channel 1 presentation when MODE switch is set to ADDED.

The Type 76-08 Amplifier is primarily intended for use in the Y cavity of the Type 765H Series Oscilloscopes.

1-2. FEATURES

- 50 Mc bandwidth at 50 mv/div sensitivity
- 5 mv/div sensitivity with 25 Mc bandwidth
- Solid state circuitry
- Cascading feature converts instrument from dual trace to a high-gain single trace unit
- X1 and X10 front-panel GAIN ADJ controls are provided for each channel to normalize gain between channels
- Polarity inversion switch enables substraction of two signals when operating in the added mode
- Ground position on coupling switch provides ground reference on baseline without necessity of grounding input of instrument
- Provides equivalent dual beam scope operation when used with Fairchild Type 74-17A Automatic Display Dual Time Base Plug-in unit

1-3. TECHNICAL SUMMARY (Specifications)

The electrical characteristics of the Type 76-08 Amplifier are listed in the Performance Specification which follows.

section 1 — technical summary

SPECIFICATIONS

Y AMPLIFIER

Bandwidth

Direct Coupled:

X1: DC to 50 megacycles; down 3 db at 50 megacycles (referenced to 50 Kc measured at 4 div p-p); never more than 4 db down at 50 megacycles

X10: DC to 25 megacycles; down 3 db at 25 megacycles; never more than 4 db down at 25 megacycles

Capacitively Coupled:

X1 or X10: Low-frequency cutoff is 16 cycles

Rise Time:

X1: 7.5 nanoseconds maximum when driven from a 25-ohm source; 7 nsec nominal

X10: 15 nanoseconds maximum; 14 nsec nominal

Note: Rise time of Test Generator should be 3 nsec or better.

Sensitivity

Cal X1: 50 millivolts/division to 20 volts/division in 9 steps of 1, 2, and 5 sequence when VARIABLE gain control is set to CAL; accurate to within ±3% when set on any one step

Cal X10: 5 millivolts/division to 2 volts/division in 1, 2, and 5 sequence

Uncal X1 or X10: Continuously variable from 5 millivolts/division to 50 volts/division. The VARIABLE gain control permits 2½ to 1 continuous sensitivity adjustments between the attenuator steps and extends the 20 volts/division range to 50 volts/division

In the X10 mode, the VARIABLE control has a range of approximately 20 to 1

Input Impedance

1 megohm shunted by 23 pf

Input Selector Switch

Each channel is provided with a 12-position rotary switch which permits ac or dc coupling of the input signal with either normal or inverted polarity for both the X1 and X10 ranges; grounds amplier input and disconnects input signal when set to ground

Calibration

The attenuator includes a CAL position which applies the line frequency square wave signal directly to the input of the Y amplifier to aid in standardizing gain (Cal: 4 div)

Signal Delay

A 200-nanosecond balanced distributed bifilar helical delay line is provided. This delay is sufficient to view baseline and the leading edge of the signal triggering the time base. The difference in delay time between CH 1 and CH 2 is 0.2 nanoseconds.

Internal Trigger

Internal triggering to the Time Base Module may be selected from the common output amplifier or from Channel 2 input signal only.

The internal trigger output signal is referenced to ground when the trace is positioned to screen center via factory adjustment of the Trig DC Level control

High Sensitivity Amplifier

A short 50-ohm cable (supplied) may be used to apply Channel 2 output to Channel 1 input via front panel connectors. Maximum sensitivity is greater than 0.5 millivolts/division; bandwidth is 5 Mc; rise time is 0.07 microsecond for cascaded amplifier operation

It should be noted that only when the channels are set up for X10 operation is the cascading feature useful

Operational Modes

The following displays are available:

1. Ch 1 only
2. Ch 2 only
3. Ch 1 & Ch 2 switched alternately
4. Ch 1 & Ch 2 time shared (Chopped)
5. Ch 1 + Ch 2 (Invert switch permits Ch 1 −Ch 2 or Ch 2 −Ch 1 presentation)

In chopped operation, the electronic switching rate is 250 Kc; each channel is nominally on 2 μsec and off 2 μsec including the blanking time of ½ μsec. Switching transients are automatically blanked.

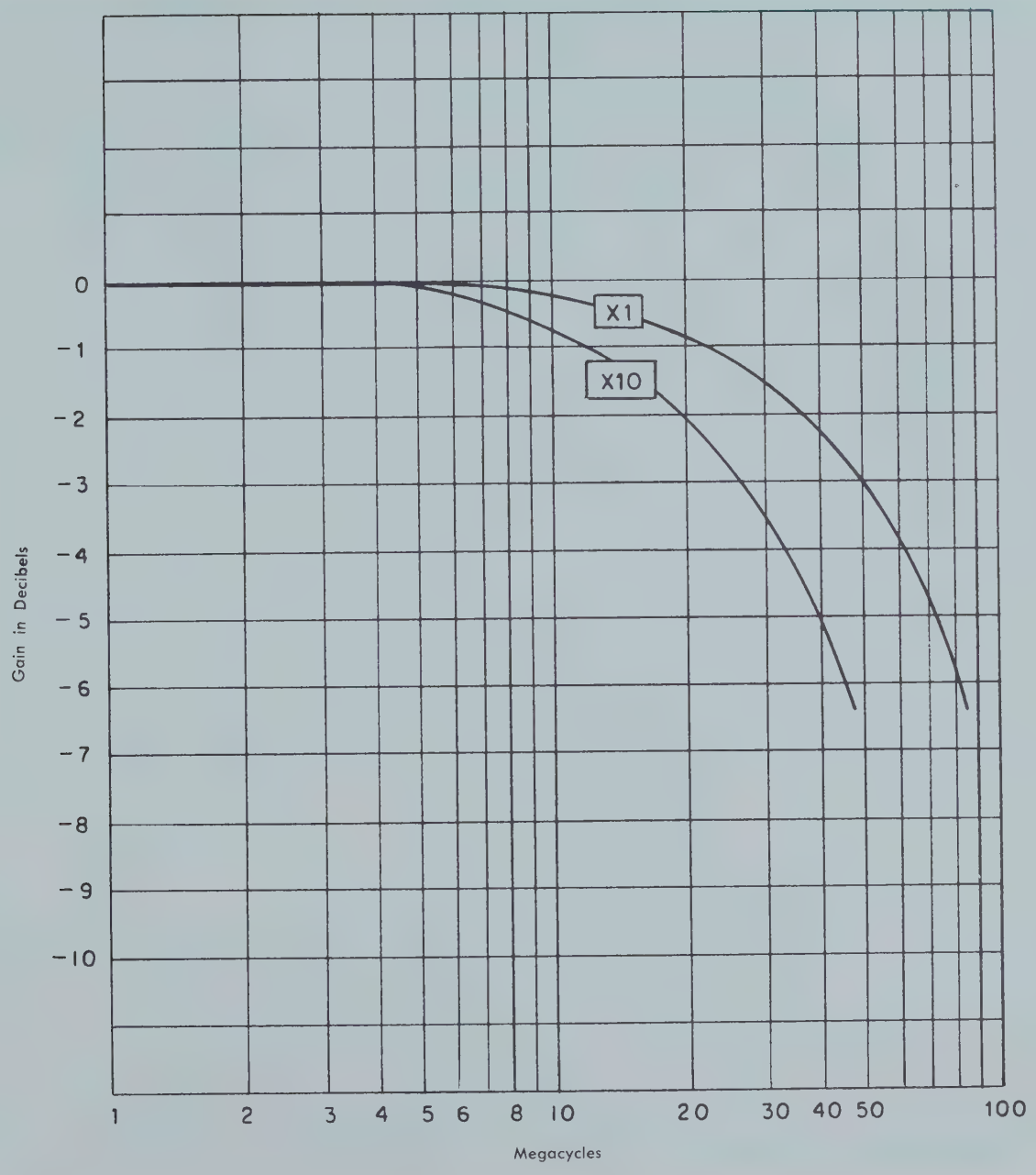
Beam Position Indicators

Two indicator lamps are located on the front panel to alert the operator as to the direction of the beam when it is positioned off the screen

Common Mode Rejection

The common mode rejection ratio is 20 to 1 from dc to 60 cycles. Common mode input signal amplitude should not exceed 1.5 times full screen

Note: MODE switch must be set to ADDED and one of the Input Selector switches set to INVERT for this operational mode.



Type 76-08 Frequency Response Curve

NOTES

SECTION 2
OPERATING INSTRUCTIONS

2-1. FIRST TIME OPERATION (Figures 2-1 to 2-3)

Unless otherwise designated, it is presumed that the Type 76-08 Plug-in Amplifier is inserted in the Y cavity (left-hand side) and the Type 74-03A Time Base Plug-in is inserted in the X cavity (right-hand side) of the Main Frame. If the Type 76-08 Plug-in unit is inserted in the X cavity of the Main Frame, it will provide horizontal deflection of the trace and the information must be translated accordingly. In the instructions which follow, capital letters within the text indicate front-panel controls, connectors, or settings.

The following illustrations are designed to aid the operator in becoming familiar with the oscilloscope:

Figure 2-1. Function of Type 76-08 Dual Channel Controls

Figure 2-2. Function of Type 76-08 Input Channel Switching Facilities

Figure 2-3. Type 76-08 Calibrator Display

2-2. APPLYING A SIGNAL

The signal (or signals) to be displayed is applied to either (or both) input connector on the front panel. To insure proper performance, the signal should be applied through a shielded cable, with the shield connected to the chassis of both the oscilloscope and the signal source.

Accessory probes are available for use with the Type 76-08 Amplifier and are listed in the Type 765 Series Oscilloscopes Instruction Manual.

2-3. VERN BALANCE ADJUSTMENT

If the DC balance of the Type 76-08 Amplifier is not properly adjusted, the reference trace on the screen will be depositioned when the VARIABLE control is rotated. To properly adjust the VERN BAL front-panel screwdriver control for Channel 1, proceed as follows:

1. Set VOLTS/DIV switch to 20, Input Selector switch to GND, and rotate VARIABLE control to its minimum gain setting.
2. Adjust the appropriate Time Base for automatic sweep to obtain a reference trace on the screen.
3. Using the POSITION control on the Type 76-08 Amplifier, position the trace to screen center (reference line).
4. Turn the VARIABLE control to the calibrated position and note any deflection.
5. Adjust the VERN BAL control until the trace is positioned to the reference line established in step 3. Do *not* change the POSITION control setting.
6. Continue to adjust the VERN BAL control until there is no depositioning of the trace when the VARIABLE control is rotated back and forth throughout its range.
7. Repeat above setup (steps 1 through 6) for Channel 2.

Note: If the adjustment range of the front-panel VERN BAL control is insufficient, refer to Section 5, Maintenance and Recalibration, for the complete Coarse and Fine Balance adjustment procedure.

2-4. SETTING GAIN OF DUAL-TRACE AMPLIFIER (X1 & X10)

Whenever the Type 76-08 Amplifier is removed from the Main Frame and inserted in another, the front-panel screwdriver GAIN ADJ control must be reset. This procedure is necessary to compensate for difference in deflection plate sensitivities. In addition, if the Type 76-08 Amplifier is switched from the Y cavity to the X cavity of the same Main Frame, readjustment will be necessary since the CRT sensitivities are different between the X and Y plates; GAIN ADJ compensates for this. To properly normalize the gain between channels or between the Plug-in unit and the Main Frame, proceed as follows:

1. Set both Channel 1 and Channel 2 VOLTS/DIV switches to CAL and turn both VARIABLE controls to CAL (fully cw).
2. Set both Input Selector switches to (X1) NORM AC (black sector).
3. Set MODE switch to CH 1 and TRIGGER switch to NORM.
4. Adjust the sweep controls for auto and line triggering.
5. Set MODE switch to ALT and adjust sweep rate for 2 milliseconds/division.
6. Set Channel 1 (X1) GAIN ADJ front-panel screwdriver control (labeled black) for 4 divisions of vertical deflection.
7. Position the traces one on top of the other.
8. Adjust Channel 2 (X1) GAIN ADJ control until only one trace may be observed (traces are superimposed).
9. Set Input Selector switch to (X10) NORM AC (green sector) and MODE switch to CH 1.
10. Repeat steps 6 through 8 using (X10) GAIN ADJ control (concentric with POSITION control).

2-5. INPUT SELECTOR SWITCH

Each channel is provided with an Input Selector switch with panel markings labeled black for X1 am-

VOLTS/DIV

One of two identical attenuators:

Calibrated X1 operation; from 50 mv/div to 20 volts/div (labeled black)

Calibrated X10 operation; from 5 mv/div to 2 volts/div labeled green for the three most sensitive ranges. For the other X10 ranges, simply divide the knob setting by 10. CAL position also provided

INPUT SELECTOR

One of two identical switches: enables selection of AC or DC coupling with NORMal or INVERTed polarity; grounds amplifier input when set to GND

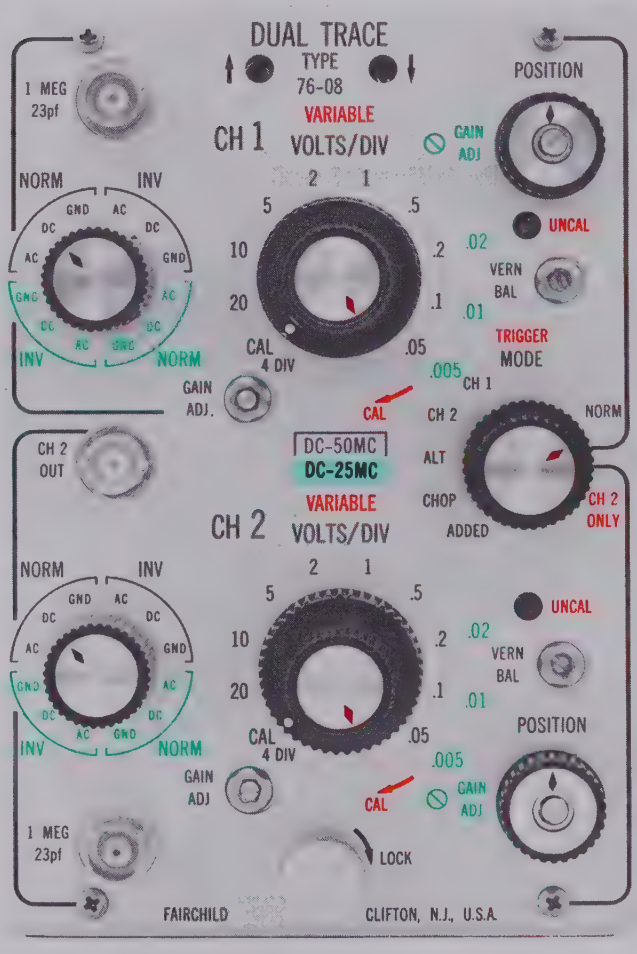
Use upper half black sectors for X1 amplifier operation; use lower half green sectors for X10 amplifier operation

GAIN ADJ (X1 & X10)

X1, black label: one of two identical screwdriver controls;

X10, green label: one of two identical screwdriver controls concentric with the POSITION control.

These controls are used for normalizing the associate channel amplifier to the Main Frame



POSITION

One of two identical controls: used to position the trace vertically

VARIABLE

One of two identical controls: provides a 1:2½ variable adjustment permitting minimum sensitivity and overlap of the VOLTS/DIV setting. A detented stop position is provided in CAL setting

VERN BAL

One of two identical screwdriver controls: when properly adjusted prevents depositioning of the pattern when VARIABLE control is used

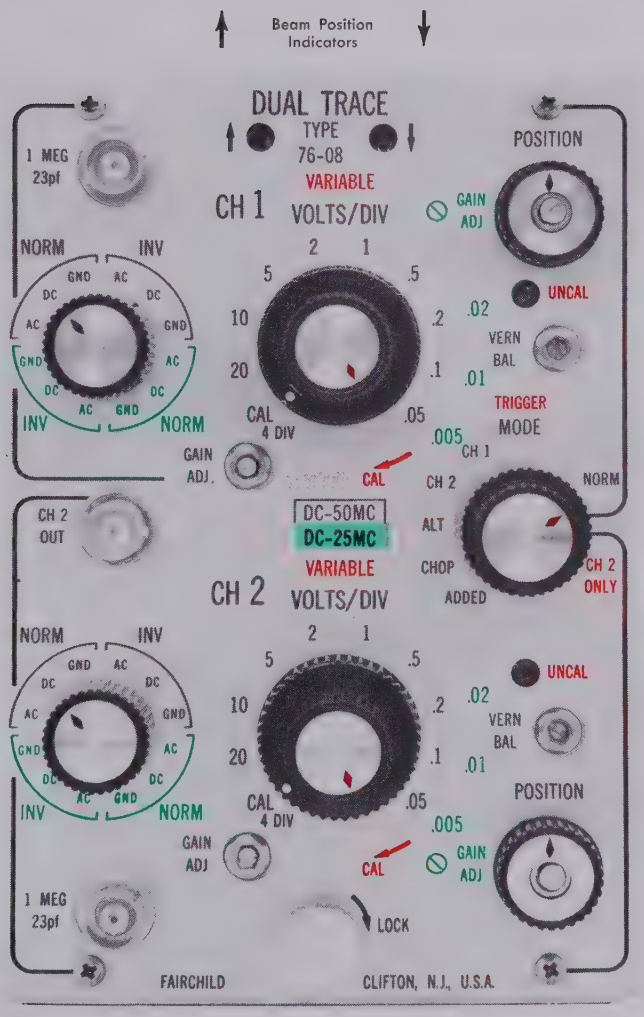
Figure 2-1. Function of Type 76-08 Dual Channel Controls

INPUT

One of two identical BNC connectors: used to applying external signals to the associate channel amplifier via the MODE switch

CH 2 OUT

BNC connector: high-sensitivity amplifier operation. A short 50-ohm cable may be used to apply Channel 2 output to Channel 1 input for 0.5 mv/div sensitivity at a bandwidth of approximately 5 Mc



TRIGGER

Switch: provides a choice of two internal trigger sources. Either Channel 2 signal or the composite signal driving the vertical deflection plates may be selected

MODE

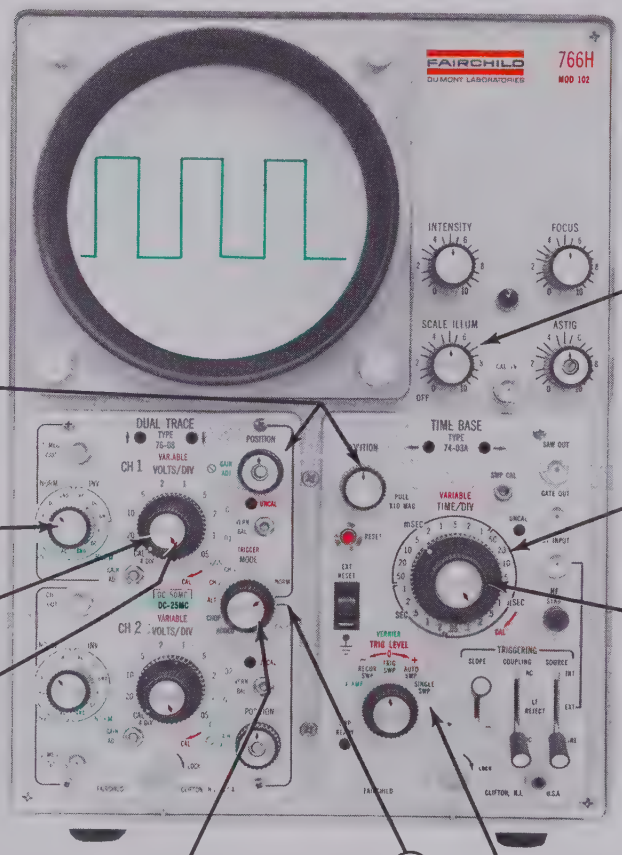
Switch: used to select the channels in the following manner:

1. CH 1 ONLY
2. CH 2 ONLY
3. CH 1 & CH 2 switched alternately
4. CH 1 & CH2 time-shared (Chopped)
5. Added: algebraic summation of Channels 1 and 2

Figure 2-2. Function of Type 76-08 Input Channel Switching Facilities

To obtain the calibrator display, set the controls exactly as shown and perform the numbered steps in sequence.

Use the same procedure when difficulty is experienced when obtaining a display. This will eliminate "cockpit" troubles due to misalignment of controls.



Set ASTIG, FOCUS and INTENSITY controls to center of range

Readjust INTENSITY, FOCUS and ASTIG controls for a sharp pattern. Readjust 6 to center the display

1 Rotate clockwise to turn on the oscilloscope

Set POSITION controls to center of range 6

2 Set outer knob (TIME/DIV) to 5 mSEC

Set to NORM AC 7

3 Rotate inner knob (VARIABLE) clockwise to CAL until switch is actuated (click is heard). Note that UNCAL lamp is off

Set outer knob (VOLTS/DIV) to CAL 8

4 Set TRIGGERING switches to +, DC, LINE

Rotate inner knob (VARIABLE) fully clockwise 9

Set outer knob (MODE) to CH 1 10

5 Set outer knob (Sweep Mode Selector) to AUTO SWP

11 Set inner knob (TRIGGER) to NORM

Figure 2-3. Type 76-08 Calibrator Display

plifier operation and green for X10 amplifier operation. This switch provides the following functions:

- ac or dc coupling of input signal
- selection of normal or inverted signal polarity
- dc to 50 Mc bandwidth, X1 amplifier operation (black sector)
- dc to 25 Mc bandwidth, X10 amplifier operation (green sector)
- ground-reference positions also provided

The Input Selector switch permits choice of retaining the dc level of the input signal or blocking the dc component of the input signal by inserting a capacitor in series with the input. If it is desired to display both the ac and dc components of a signal, set this switch to NORM DC. Thus, the position of the display at any instant is a function of the instantaneous signal voltage with respect to ground.

There are times when it is neither necessary nor desirable to display the dc component of the input waveform. A capacitor placed in series with the input connector will exclude the dc component while simultaneously permitting the ac component to be displayed. This is accomplished when the Input Selector switch is set to NORM AC. The effect of the dc component is now excluded from the display.

It should be noted that when the Input Selector switch is set to the AC position, the lowest frequency limit (3 db) of the amplifier is about 16 cycles. Therefore, some low-frequency distortion and loss amplitude will occur if the pattern on display contains frequency components below the specified cutoff. Use of a 10:1 Attenuator Probe brings low frequency as response to 1.6 cycles.

When using the dual-trace features of the Type 76-08, you may desire to invert the displayed waveform. In the NORM position of the Input Selector switch, the displayed waveform will have the same polarity as the applied signal. When the Input Selector switch is set to INVERT, the displayed waveform will be inverted. In other words, a positive-going pulse will be displayed as a negative-going pulse.

2-6. OBTAINING A DISPLAY

To use the Type 76-08 Amplifier to obtain a display, proceed as follows:

1. Signals to be observed are connected to the Type 76-08 Amplifier through the Channel 1 and/or Channel 2 BNC connector via shielded cable or an Attenuator Probe.

2. Establish a common ground between the oscilloscope chassis and the signal source.

3. If it is desired to display a single trace with the Type 76-08 Amplifier, simply apply the signal to either Input connector and set the MODE switch to the corresponding channel.

4. To display a single signal independently when the same or two different signals are applied to the channel input connectors, set the MODE switch to CH 1 to display only the Channel 1 input; to CH 2 to display only the Channel 2 input.

5. To display two signals simultaneously, connect a signal to each Input connector and set the MODE switch to ALT or CHOP. The chopped position is used when it is desired to reduce the "flickering" of the display when observing input signal data at slow sweep speeds (below 1 millisecond/div). External triggering of the Time Base or CH 2 ONLY triggering is to be preferred in chopped position to prevent the sweep from triggering on the "chopping" signal. In general, the CHOP position is used with lower sweep rates and the ALT position with higher sweep rates.

6. To display the algebraic sum of two signals, connect a signal to each Input connector and set the MODE switch to ADDED (Ch 1 + Ch 2).

7. To display the algebraic difference of two signals, apply a signal to each Input connector and set the MODE switch to ADDED. For Ch 1 minus Ch 2 presentation, set Channel 1 Input Selector switch to NORM and Channel 2 Input Selector switch to INVERT. For Ch 2 minus Ch 1 presentation, set Channel 1 Input Selector switch to INVERT, and Channel 2 Input Selector switch to NORM.

8. Adjust the appropriate Time Base Plug-in controls to obtain a stable display of the pattern.

9. Set the VOLTS/DIV switch and POSITION control such that the size and position of the display is as desired on the screen.

2-7. ADDITIONAL HINTS

In addition to the information given in the paragraphs preceding, observe the following precautions when applying signals to the oscilloscope:

1. Avoid errors in reading due to stray coupling between circuits, particularly in the signal lead. As a rule, do not use long, unshielded leads for applying signals to the oscilloscope. This fact holds for the audio-frequency spectrum, except possibly when making measurements on low impedance circuits at very low frequencies. Coaxial or shielded input cables are recommended for most applications. (Types 7080 or 7082.)

2. In broadband applications, it may be necessary to terminate a coaxial cable with a resistance equal to its characteristic impedance. This is done to prevent standing waves or ringing (high-frequency damped oscillations).

3. To avoid erroneous results, the operator should simulate the actual operating conditions of the equipment being tested. For example, the equipment should work into a load impedance equal to that which it will see in actual use.

4. Consider the effect of loading upon the signal source due to the input impedance of the oscilloscope.

The input impedance can be represented by a resistance shunted by a capacitance. The effective value of this impedance is indicated in the Specifications. However, the operator should be aware that even with a few feet of cable in the input circuit, the loading capacitance on the circuit under investigation might be greater than 100 pf.

5. There are cases when connecting the input of the oscilloscope to a signal source, the effect of loading the source is not negligible. To minimize this loading and therefore obtain a valid measurement, a probe may be used in the manner described in the paragraph entitled "Use of Probes".

6. Care must be exercised when applying a fast rise, high-frequency signal to the Input connector. It is necessary to match and properly terminate the coaxial cable applying the signal to the oscilloscope or ringing on the rising and falling portion of the waveform will result.

7. As the length of the cable is increased, the necessity for proper termination becomes very important. This termination is generally inserted at the oscilloscope end of the cable, although many signal sources may require an additional termination at the other end of the cable.

8. The plug-in input shunt capacity of 23 pf presents a reactive load of 140 ohms at 50 Mc. This 140 reactive ohms will load a 50-ohm generator.

A 50-ohm terminator such as the Fairchild Type 4285A will present a 50-ohm source impedance to the plug-in and will optimize high-frequency accuracy by minimizing loading of the source by the plug-in.

9. Passive attenuator probes will generally reduce bandwidth and slow the display system rise time. Consider the effect of probe loading and response in your measurements. See paragraph entitled "Use of Probes".

For rack-mounting systems, observe the following precautions if long shielded cables are used.

1. It may be desirable to ground long shielded leads only at one end to avoid circulation currents. Even microamperes of extraneous currents in the shielded braid can cause unwanted distortions.

2. Use cable with insulation over the shielded braid so that the cable shield does not accidentally touch ground.

3. Use off-ground insulated bulkhead feed-thru connectors where applicable.

4. Do not pass cables near strong ac magnetic fields.

5. Long shielded input cables may also induce parasitic oscillations. It is suggested that a 100-ohm to 1000-ohm ½-watt resistor be connected in series with the center conductor near or at the oscilloscope input terminals.

6. Use a resistance at least twice that required to just stop the parasitic oscillations. Too large a value may reduce the bandwidth of the system.

2-8. USE OF PROBES

An attenuator probe lessens both the capacitive and resistive loading caused by the oscilloscope to a minimum value. Simultaneously, while isolating the oscilloscope from the signal source, it reduces the effective sensitivity of the instrument. In other words, the displayed waveform will be reduced in amplitude by the attenuation factor of the probe. The attenuation introduced by the probe permits measurement of signal voltages in excess of those which may be accommodated by the instrument.

When using a probe to sample signals from a tuned, matched, or otherwise critical circuit, capacitive loading may cause erroneous readings. In these cases it may be necessary to remove capacity and resistance from the circuit under observation. When the observations and adjustments are completed, capacitance and resistance precisely equal to that of the probe impedance, should be added to the circuit after the probe is removed from the circuit. This substitution will equalize loading and restore the operating characteristics of the circuit under observation to the same conditions when probe measurements were made.

When using the attenuator probe to make amplitude measurements, multiply the observed amplitude of the display by the attenuation factor marked on the probe.

The Accessory Probes listed in Section 1 of the Type 765 Series Instruction Manual, have an attenuation factor of 10 to 1. The maximum voltage that may be applied to these probes is 600 volts dc plus peak ac. Voltages in excess of this value (either dc volts or peak ac volts) may cause damage to components inside of the probe housing.

IMPORTANT: Before using the probe, always check its adjustment.

An adjustable capacitor in the probe compensates for variations in input capacitances from one unit to another. To insure accuracy in pulse and transient measurements, check the probe adjustment frequently. To check the probe, proceed as follows:

1. Connect the Probe to Input BNC connector on the Type 76-08 and apply the probe tip to the 1V CAL pin jack on the Main Frame. Set Input Selector switch to DC.

2. Adjust the oscilloscope to display several cycles of the calibrator waveform.

3. Adjust the variable capacitor in the body of the probe for a flat-top trace on the screen.

4. To preserve the waveform of the signal being displayed, clip the probe ground lead to the chassis of the equipment being tested. Select a short, clean, ground point near the probe input connection.

NOTE: For optimum response, use the Type 4290 Probe (4′). Even this high performance probe causes the system to have lesser bandwidth and slower rise time. Using the Type 4290 Probe, a nominal 42 Mc bandwidth and a rise time of 8½ nanoseconds may

be expected; using the Type 4298/4299 Probes, (8′ & 6′ respectively) the bandwidth falls to 33 Mc and rise time is 11 nanoseconds.

2-9. DUAL-TRACE OPERATION

Using the Type 76-08 Dual Trace Plug-in makes it possible to view two different time-shared vertical input signals displayed against one time base. The electronic switch will alternately accept either the Channel 1 or Channel 2 signal when the MODE switch is set to ALT. Each channel retains individual control of sensitivity, position, polarity, etc. Should the sweep rate be so low that the display has excessive flicker, the MODE switch may be set to CHOP position. The electronic switch will now chop the signals at approximately 250 Kc rate. Switching transients will automatically be blanked for a clean, undistorted display.

The dual-trace display applications include comparisons of the input and output of the amplifiers, multivibrators, shaping circuits, comparative phase and time delay measurements, etc.

Do not use normal internal triggering when in the chopped mode, since the random switching transients will cause poor synchronization of the sweep.

2-10. DUAL-TRACE TRIGGERING

a. Introduction

For simplicity of operation, dual-trace triggering may be categorized as follows:

1. External triggering using alternate or chopped modes of operation.
2. Internal triggering using the alternate mode.
3. Internal triggering using the chopped mode.

b. External TRIG Using CHOP or ALT Modes

For dual-trace operation, it is preferable to trigger the time base with an external signal which bears a fixed time relationship to the applied signal. One of the applied signals may normally be employed as the external triggering signal. When this technique is used, a stable display is more readily obtained, and the true time or phase relationship of the two signals is discernible.

In low frequency applications, one of the applied signals may be used as the external triggering signal. In general, useful stable displays may be obtained by this technique without excessively loading the signal source. However, in high-frequency applications, such a method for deriving the triggering signal loads down the signal source resulting in an unsatisfactory display. Therefore, a nonloading method must be used for obtaining the external trigger. For example, if the Fairchild Type 781 Time-Mark Generator is the signal source, use the TRIGGER OUT pulse from this generator to externally trigger the oscilloscope.

c. Internal TRIG Using ALT Mode

Internal triggering of the time base may be used if the time or phase relationship between the two signals is not critical. In alternate mode of operation, the signal applied to the Type 76-08 internally triggers the Time Base Module, which in turn switches the channels at the completion of each sweep cycle during the retrace intervals.

Hence, it is important to set the Time Base TRIG LEVEL control to a point where the sweep can trigger on the signal applied to each channel. If one of the applied signals possesses a smaller amplitude than the other, then the TRIG LEVEL control must be set for reliable triggering on the smaller amplitude signal to insure the successful operation of the alternate mode switching cycle. Also, to avoid triggering on the change in dc positioning level between channels, set the Time Base Coupling switch to ACF or LF REJECT.

As an alternative, the Type 76-08 may be set up for single channel internal triggering in the alternate mode by setting the TRIGGER switch to CH 2 ONLY.

d. Internal TRIG Using CHOP Mode

For dual-trace chopped-mode operation, use CH 2 ONLY mode for reliable internal triggering. The advantages of internal triggering on CH 2 ONLY are:

- increased sensitivity with effectiveness of using external trigger
- decreased loading
- minimum cabling to the oscilloscope
- two effective external trigger inputs

2-11. DUAL X-Y DISPLAYS

It is possible to display two different sets of X-Y parameters on the Type 765H Family of Oscilloscopes through the use of two Type 76-08 Plug-in Amplifiers. This technique is useful if it is desired to observe operating characteristics of two identical items, such as electron tubes, under different operating conditions. To display two sets of X-Y parameters simultaneously, proceed as follows:

1. Insert a Type 76-08 Plug-in into each cavity of the Type 765H Series Oscilloscopes.
2. Set the MODE switch of one plug-in unit to CHOP and the other one to ALT.
3. Apply one pair of signals to the Channel 1 Input connectors and the other pair of signals to the Channel 2 connectors.
4. Set the VOLTS/DIV switches and the POSITION controls for the desired display.

2-12. SETTING UP AMPLIFIER FOR GREATER INPUT SENSITIVITY

The Type 76-08 Dual Trace Amplifier may be set up to provide an input sensitivity greater than 0.5 millivolts/division with an accompanying reduction in bandwidth. This is accomplished by connecting a short 50-ohm cable (supplied) between the CH 2 OUT BNC connector to the CH 1 Input connector on the Type 76-08. The output from Channel 2 amplifier is now in series with the input of Channel 1 amplifier.

Next, apply the desired signal to Channel 2 Input connector. Set the TRIGGER switch to NORM and the MODE switch to CH 1. The maximum over-all input sensitivity will now be greater than 0.5 millivolts/division. Application of this technique for achieving greater sensitivity causes the system to have lower bandwidth and slower rise time. A nominal 5 Mc bandwidth and a rise time of 70 nanoseconds may be expected from cascaded amplifier operation.

2-13. VOLTAGE MEASUREMENTS

NOTE

When making voltage measurements, make sure there is a common ground between the oscilloscope and the signal source.

a. General

The Type 765 Family of Oscilloscopes may be used to measure the voltage of the input signal by using the calibrated VOLTS/DIV setting and observing the height of the display on the screen in graticule divisions.

When making voltage measurements, the operator should try to set up the instrument for full scale vertical deflection to insure maximum accuracy. Also, it is important to remember that the width of the trace may be an appreciable part of the over-all measurement. This is particularly true when you are measuring signals of small amplitude or when stray signal pickup has broadened the trace. The operator should consistently make all measurements from one side of the trace. If the top side of the trace is used for one reading, it should be used for all succeeding readings.

b. How to Measure Peak-to-Peak Voltages Using the CRT Scale

The procedure employed for all voltage measurements is basically the same. The VARIABLE control must be set to CAL. The specific examples that follow are intended to show the general procedure. These examples may be adapted to fit any particular application.

To measure the ac component of the signal on display, set the Input Selector switch to AC. In this position, only the ac components of the input signal are displayed on the screen. However, when the ac components of the input is of very low frequency (under 16 cps), set the Input Selector switch to DC to prevent errors.

To make measurements, proceed as follows:

1. Using the calibrated scale, measure the vertical deflection in graticule divisions from the positive peak to the negative peak of the waveform. See Figure 2-4.
2. Multiply the vertical dimension obtained in step 1 by the VOLTS/DIV switch setting to obtain the indicated voltage.
3. Multiply the indicated voltage obtained in step 2 by the attenuation factor of the probe, if one is used, to obtain the actual peak-to-peak voltage.

For example, suppose that you are using a 10:1 Attenuator Probe and the VOLTS/DIV switch is set to 0.1. Assume that the vertical distance between the peaks of the waveform measures 4 graticule divisions. Now, this graticule dimension of 4 is multiplied by the VOLTS/DIV setting of 0.1 to give 0.4 volt. Next, multiply this result by 10, if a 10:1 Attenuator

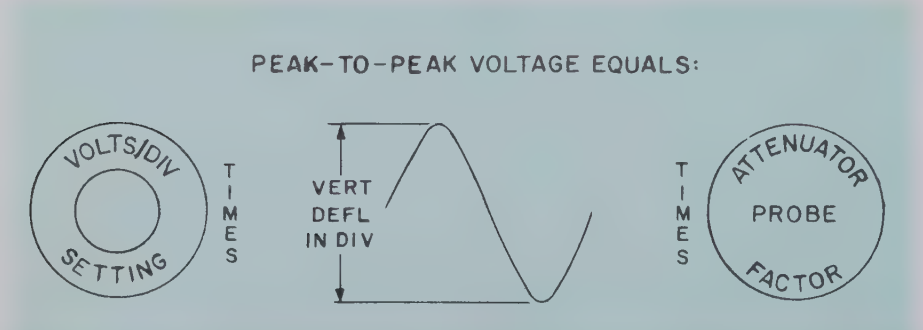


Figure 2-4. Peak-to-Peak Voltage Measurements

Probe is used. This gives 4 volts as the peak-to-peak voltage of the display waveform.

Note: Always make sure that the VARIABLE control is set to CAL when making measurements.

c. How to Measure Instantaneous Voltages with Respect to Ground (or Some Reference Potential) Using the CRT Scale

The technique used for measuring instantaneous voltages with respect to a reference point, is virtually the same as that described for peak-to-peak voltage measurements. The difference is that now a reference point must be established on the screen of the oscilloscope. Since voltage measurements with respect to ground are the most common, the procedure which follows, establishes ground as the reference point. The same general technique may be used for instantaneous measurements with respect to any other potential, just so long as that potential is employed to establish the reference point.

To make measurements, proceed as follows:

1. Set the Input Selector switch to DC.
2. Adjust the appropriate Time Base Plug-in controls to obtain a reference trace.
3. To establish the reference point, touch the probe tip to the ground terminal on the oscilloscope (or to the desired source potential, if a point other than ground is used). Vertically position the trace to a convenient point on the screen. This point should be chosen so that it lies on one of the major horizontal scale divisions. The chosen horizontal scale line, which is now coincident with the trace, is the reference line from which all voltage measurements are to be made.
4. Disconnect the probe tip from ground and connect it to the signal source without disturbing the POSITION control.
5. Adjust the oscilloscope controls for a suitable and stable display.
6. Using the calibrated scale, measure the number of graticule divisions from the desired point on the waveform to the pre-established reference line set up in step 3. See Figure 2-5.
7. Multiply the graticule dimension obtained in step 6 by the VOLTS/DIV switch setting to obtain the indicated voltage. Make sure that the VARIABLE control is set to CAL.
8. Multiply the indicated voltage obtained in step 7 by the attenuation factor of the probe used to obtain the actual instantaneous voltage.

For example, suppose that you are using a 10:1 Attenuator Probe and the VOLTS/DIV switch is set to 0.1. Assume that the vertical distance between the desired point on the waveform to the pre-established reference line is 4 graticule divisions. Now, multiply this vertical deflection of 4 divisions by the VOLTS/DIV setting of 0.1 to give 0.4 volt. Next, multiply this result by 10, the attenuation factor of the probe. This shows that the instantaneous voltage with respect to ground to be 4 volts. Since the voltage point is above the reference line, the indicated polarity is positive.

2-14. MEASURING SHORT RISE TIMES

The rise time is defined as the time between 10% and 90% of the amplitude.

Connect the circuit under investigation with a 50-ohm cable RG-8A/U, terminated with a Type 4285A pad to the input of the oscilloscope. The rise time of the circuit is expressed in the form

$$T = \sqrt{T^2_{crt} - T^2_{ampl}}$$

in which T_{crt} is measured rise time on the oscilloscope and T_{ampl} is the rise time of the Type 76-08 which is 7.5 nanoseconds.

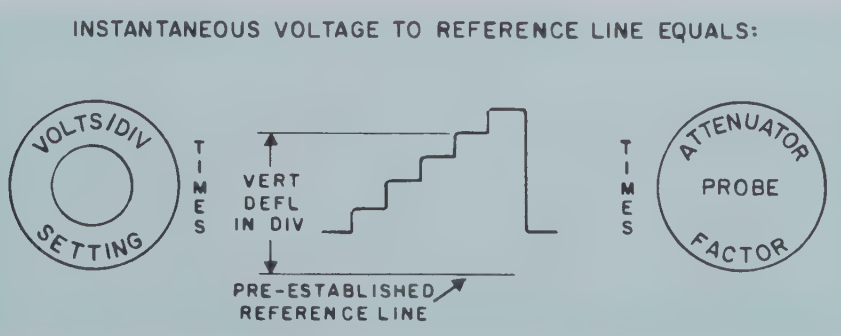


Figure 2-5. Instantaneous Voltage Measurement with Respect to Ground (or Some Other Reference Potential)

NOTES

SECTION 3
CIRCUIT DESCRIPTION

3-1. INTRODUCTION

To simplify circuit description of the Type 76-08 Dual Trace Amplifier, functional block diagrams are provided as follows:

Figure 3-1. Type 76-08 Input Circuit, Simplified Functional Block Diagram
Figure 3-2. Type 76-08 Channels 1 & 2, Simplified Functional Block Diagram
Figure 3-3. Type 76-08 Electronic Switching Circuits, Functional Block Diagram
Figure 3-4. Type 76-08 Y Deflection Amplifier, Functional Block Diagram
Figure 3-5. Type 76-08 Trigger Amplifiers, Functional Block Diagram

Refer to Figure 5-1 in the Maintenance and Recalibration Section for the over-all system block diagram.

The circuit description will be keyed to the above-mentioned illustrations. Emphasis is placed on the interrelation of circuits rather than on detail of operation. It is also recommended that the schematics at the rear of the manual be referred to in following the circuit description.

3-2. INPUT AMPLIFIER CIRCUIT DESCRIPTION

a. Input Channel (Figure 3-1)

The Type 76-08 Plug-in is a two-channel amplifier designed for use with the Type 765H Series Oscilloscope. It consists of two identical input channels (Channel 1 and Channel 2), an electronic switching system, and a common vertical deflection amplifier. The output of either or both input channels may be applied to the common vertical amplifier depending on the setting of the MODE selector switch.

Each input channel consists of an attenuator and a pre-amplifier. Since the input channels are identical, the circuit description will refer to Channel 1 only. Operation of Channel 2 will be the same as Channel 1 except where otherwise noted.

The Input Selector switch permits choice of retaining the dc level of the input signal or blocking the dc component of the input signal by inserting a capacitor in series with the input. When this switch is set to the NORMal sector, the displayed waveform will have the same polarity as the applied signal. The dis-

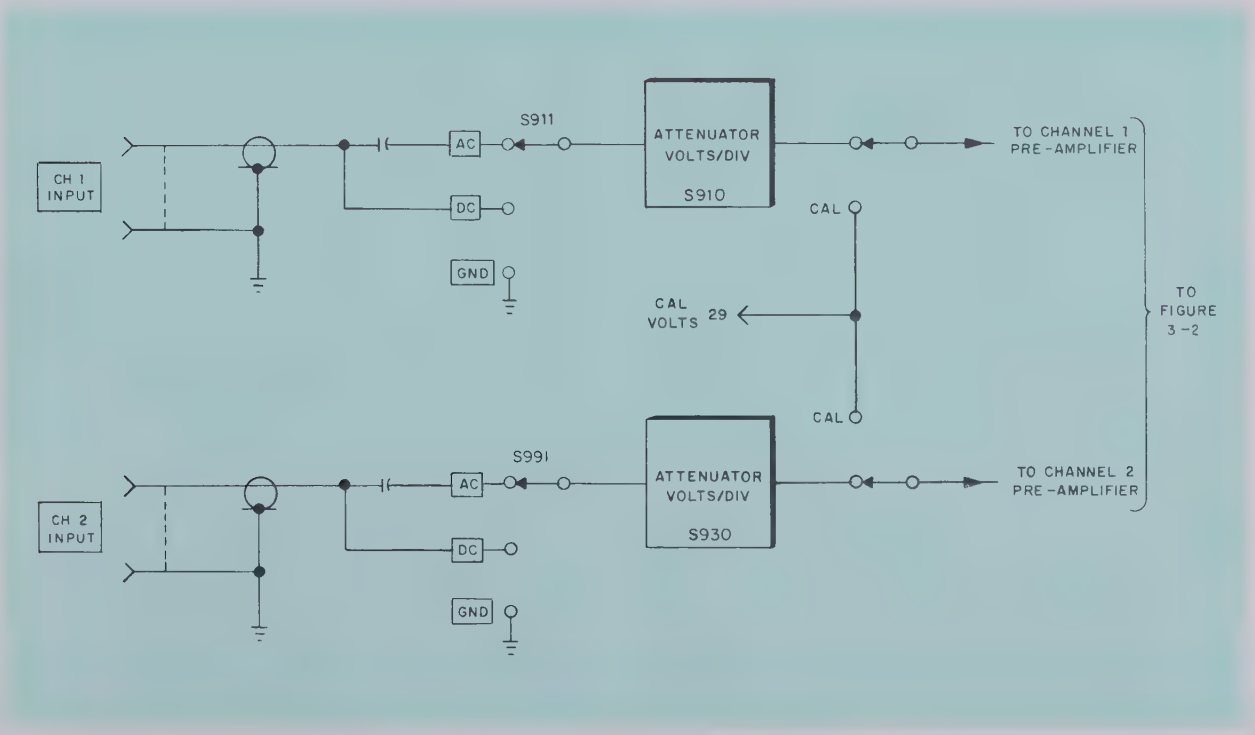


Figure 3-1. Type 76-08 Input Circuit, Simplified Functional Block Diagram

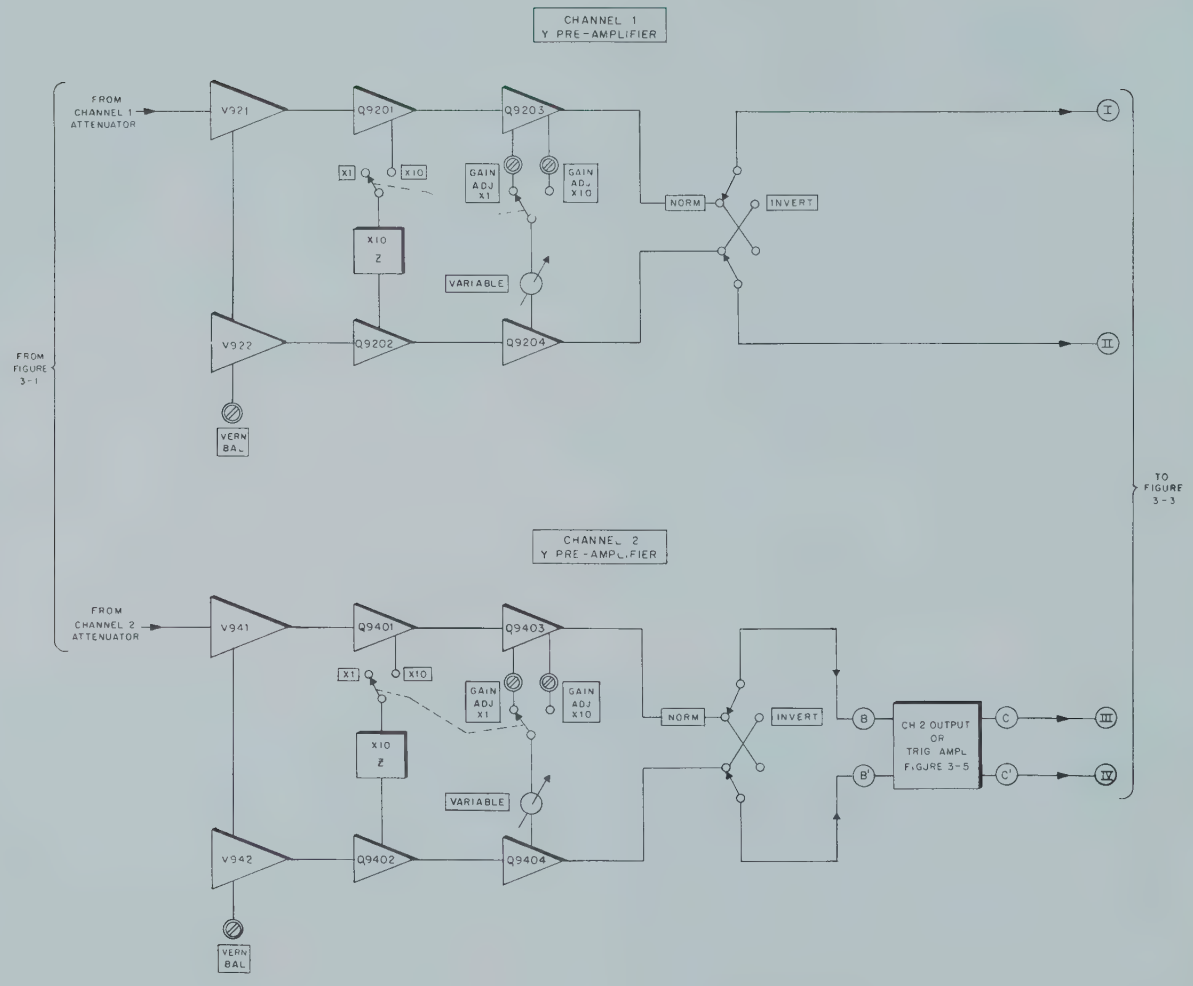


Figure 3-2. Type 76-08 Channels 1 & 2, Simplified Functional Block Diagram

played waveform will reverse polarity when the switch is set to the INVert sector. If this switch is used when the MODE switch is set to ADDED, the unit may be set up for CH 1 minus CH 2 or CH 2 minus CH 1 presentation. A GND position is provided on the Input Selector switch to facilitate the dc balancing of the input amplifier.

The VOLTS/DIV switch permits the desired attenuation of the input signal in calibrated steps as indicated by the front-panel markings. When the Input Selector switch is set to the NORM and INV sectors labeled in black, the maximum gain of the amplifier is 50 millivolts/division at a bandwidth from dc to 50 megacycles. The gain of the amplifier is changed by a factor of 10 when the Input Selector switch is switched to the green sectors. The maximum sensitivity of the amplifier is now 5 millivolts/division at a bandwidth from dc to 25 megacycles.

An internal calibrating voltage is applied to the grid of the input dc amplifier when the VOLTS/DIV switch is set to CAL. This switch automatically disconnects the Y Input signal from the amplifier when the calibrator signal is applied. The X1 and X10 GAIN ADJ front-panel screwdriver controls are employed to normalize the gain between channels and between the Plug-in module and the Main Frame. When gains are normalized, the peak-to-peak value of the calibrator waveform will indicate 4 divisions of vertical deflection on the screen.

b. Pre-Amplifier (Figure 3-2)

The nuvistor input amplifier V921 & V922, converts the single-ended input signal at the grid of V921 to a push-pull output signal at the plates of V921 & V922.

Resistors R9208 and R9211 in series with the grids of these tubes, serve to suppress any parasitic high-frequency oscillations. Resistor R9203 is provided to limit grid current in the event that any excess voltage is applied to the input.

Undesirable voltages are developed at the grid of V921 due to gas and leakage currents. The grid resistor R9220 is returned to a variable potential which is controlled by the GAS Comp potentiometer, R9210, to compensate for possible grid current.

The VARIABLE control is connected between emitters of Q9203 and Q9204 in the gain control stage. Any difference in the dc level between the two emitters will cause the trace to shift vertically as the VARIABLE control is rotated. The DC BAL control nulls the dc voltage across the VARIABLE control so that in the absence of an input signal, there will be no depositioning of the trace when the VARIABLE control is rotated throughout its range. When the VARIABLE control is not set to CAL, the UNCAL lamp lights and serves as a warning indicator when using uncalibrated or vernier gain setting.

The POSITION control is introduced in the emitters of amplifier Q9205 and Q9206 and allows vertical positioning of the trace. Also, these amplifiers are switched on or off by the electronic switching circuits so that the modes of operation as indicated by the front-panel MODE switch can be obtained.

3-3. ELECTRONIC SWITCH CIRCUIT DESCRIPTION (Figure 3-3)

a. Blanking Multivibrator

Selection of the input channel whose output is to be applied to the common vertical deflection amplifier, is accomplished by means of the Electronic Switching circuit.

The timing of the electronic switch Q9601 and Q9602, is provided by the blanking multivibrator Q9605 and Q9606. The blanking multivibrator may be switched to either a monostable or a free-running condition by the MODE switch S960. When the MODE switch is set to CH 1, CH 2, ADDED (Ch 1 + Ch 2), or ALT, a negative bias is applied through resistor R9653 to the base of transistor Q9606. This action locks the blanking multivibrator in the monostable state with Q9606 turned off and Q9605 turned on.

When the MODE switch is set to CHOP, this bias voltage is removed, permitting free-running operation of this stage at a repetition rate of 250 Kc. This gating voltage is applied to the electronic switch which alternately functions to turn Channels 1 and 2 off and on at a 250-Kc rate, independent of the sweep rate. Each channel is *on* approximately 2 microseconds, and *off* for 2 microseconds including the blanking time of ½ μsec.

External triggering of the Time Base is to be preferred in the chopped position to prevent triggering of the sweep on the *chopping* signal.

The timing of the blanking multivibrator is determined by the master trigger from the unblanking amplifier of the Time Base unit. This positive-going master trigger is coincident with the trailing edge of the sweep gate and is applied through the emitter follower Q9607 to the base of Q9606, turning it on momentarily. Consequently, one narrow negative pulse is generated at the collector of Q9606 for each positive trigger input. However, in the free-running position only, the output of the blanking multivibrator is independent of the input triggering signal.

It is necessary to turn off the cathode-ray tube beam during switching in the chopped position. This is accomplished by applying the negative pulse generated at the collector of Q9606 to the switch-transient blanking amplifier Q9609. The resulting +35-volt blanking pulse is applied to pin 4 of the interconnecting plug to the cathode of the CRT.

b. Electronic Switch

When the MODE switch is set to ADDED, the B+ voltage for the electronic switch Q9601 and Q9602, is disconnected. This allows both preamplifier channels to work simultaneously, thus providing a computer type algebraic adder circuit (no common mode rejection) for Channels 1 and 2. Use of the INVert switch (polarity inversion) may give Channel 1 minus Channel 2 or Channel 2 minus Channel 1 presentation.

In positions CH 1 or CH 2 of the MODE switch, a cut-off bias is applied to the appropriate side of the electronic switch holding the inactive channel in a continuous cut-off position. In other words, the electronic switch is locked, (Q9601 is continually on, and Q9602 is continually off, or vice versa) and will not respond to the triggering signals from the blanking multivibrator.

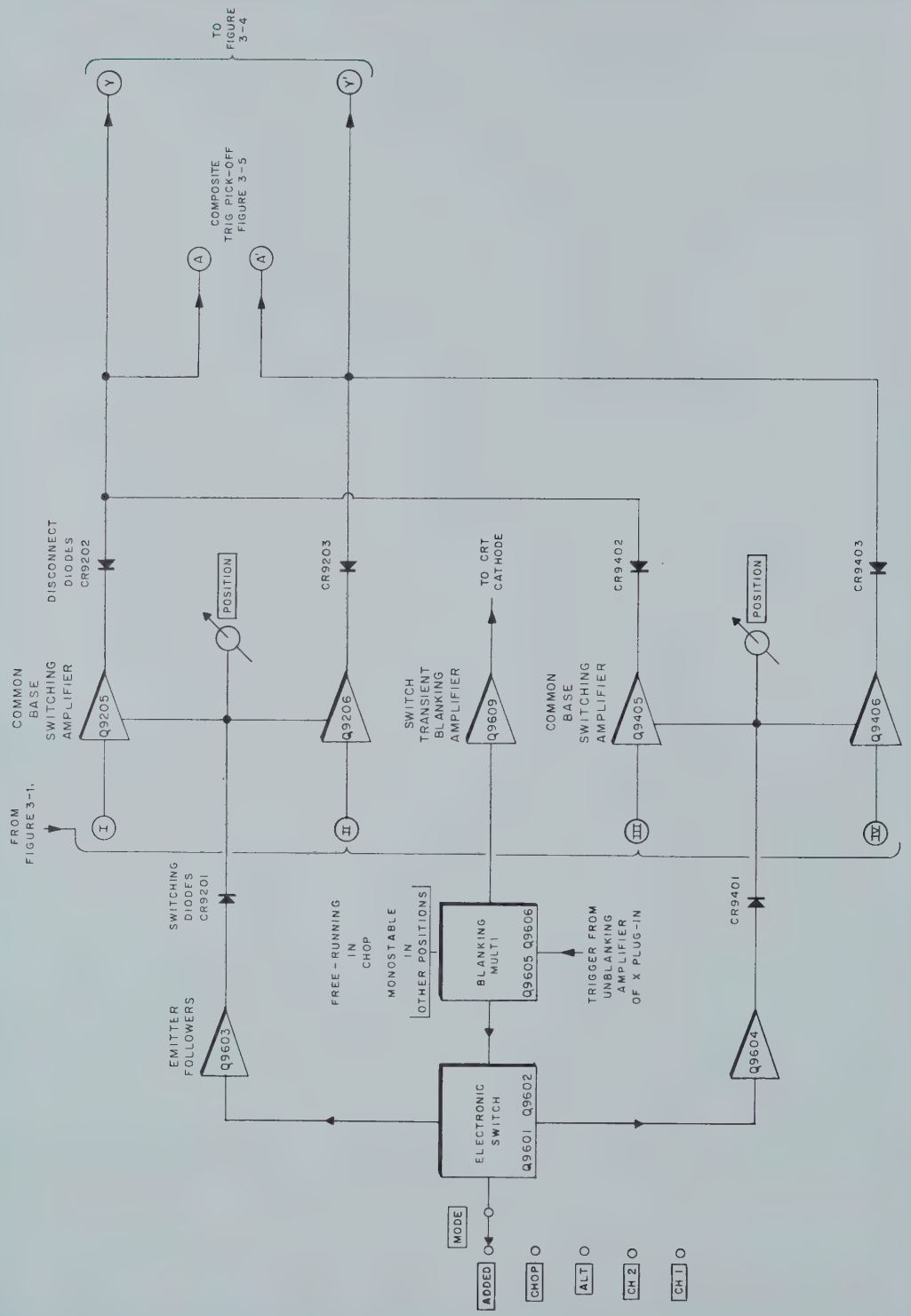


Figure 3-3. Type 76-08, Electronic Switching Circuit Functional Block Diagram

For example, when the MODE switch is set to CH 2, a fixed bias is applied through R9603 to the base of Q9601, cutting it off; at the same time, Q9602 is fully conducting. The elevated voltage at the collector of Q9601 is applied through emitter follower Q9603 to the anode of switching diode CR9201 causing it to conduct. The emitters of Channel 1 switching amplifiers, Q9205 and Q9206 are raised, thus plunging this stage into cutoff. Hence, Channel 1 preamplifier output is arrested at this point.

Transistor Q9604 is back-biased by the depressed voltage from Q9602. This permits the emitters of Q9405 and Q9406 to operate at their normal bias. Thus, only Channel 2 output progresses to the common vertical deflection amplifier.

When the MODE switch is set to CH 1, just the opposite condition exists. Channel 2 stage, Q9405 and Q9406, is cut off and Channel 1 stage, Q9205 and Q9206 conducts.

Diodes in the collector leads of each of the switching output stages of the preamplifier disconnect the collectors when the amplifier is turned off. This technique isolates the active adjacent channel collectors which would otherwise be in parallel with the inactive channel and cause capacitive loading. In this way, the maximum available bandwidth may be maintained.

In the ALT or CHOP positions of the MODE switch, no fixed bias is applied and the electronic switch may now be keyed at will by the blanking multivibrator. Thus, transistors Q9601 and Q9602 are now operating as a bistable switching multivibrator.

When the MODE switch is set to ALT, the cathode-ray tube displays the signal in one channel for one sweep of the beam, and the signal in the other channel for the next sweep of the beam.

3-4. COMMON DEFLECTION AMPLIFIER (Figure 3-4)

The output from the channel switching amplifier is applied to the common emitter followers Q9501 and Q9502. A balanced distributed bifilar helical delay line is incorporated in this amplifier. The delay time provided is sufficient to view baseline and the leading edge of the signal triggering the time base when the instrument is set up for internal triggering.

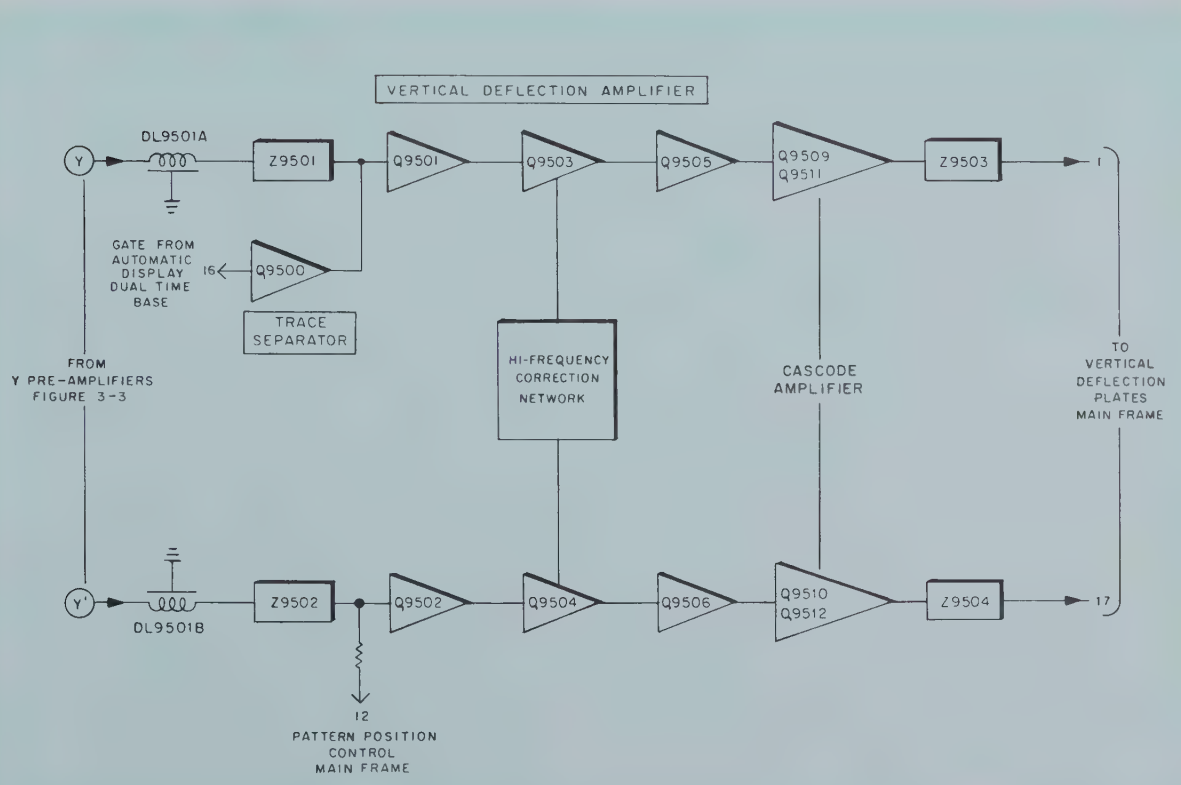


Figure 3-4. Type 76-08 Y Deflection Amplifier, Functional Block Diagram

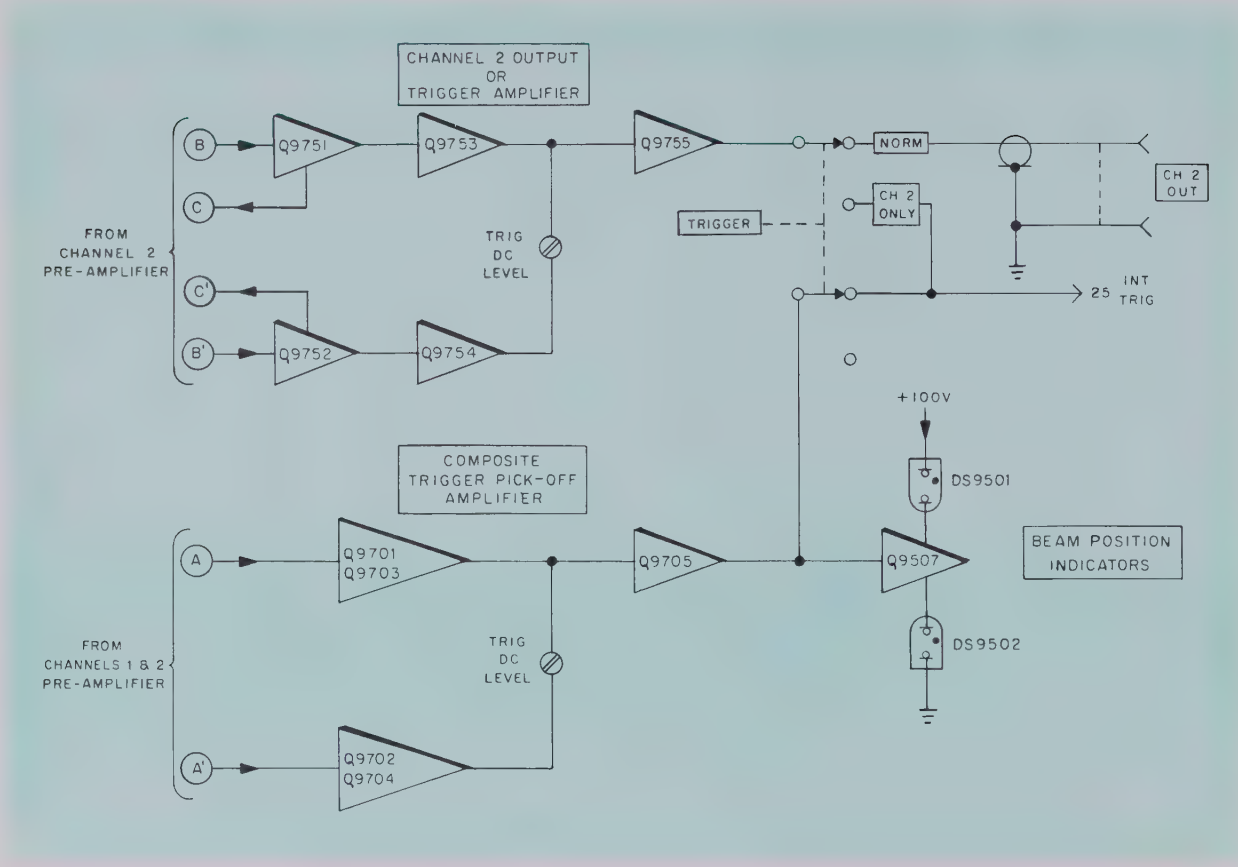


Figure 3-5. Type 76-08 Trigger Amplifiers, Functional Block Diagram

Proper delay line termination is provided by filters Z9501 and Z9502 which compensate for the input capacitance of transistors Q9501 and Q9502 respectively.

When the Automatic Display Dual Time Base Plug-in is used in the X cavity, a gate signal is coupled from it to Q9500 for automatic separation of the various displays. The signal progresses through the common deflection amplifier as indicated in Figure 3-4.

3-5. TRIGGER PICK-OFF AMPLIFIER (Figure 3-5)

a. Introduction

The Type 76-08 Dual Trace Amplifier provides a choice of two internal trigger sources: Composite and Channel 2 Only. Either of these sources may be selected by the TRIGGER switch.

b. Channel 2 Only Internal Trigger

The Channel 2 Only internal trigger is derived from the collectors of Q9401 and Q9402 located in Channel 2 preamplifier. Transistors Q9751 and Q9752 are connected as emitter followers which serve to isolate Channel 2 preamplifier pick-off point from the trigger amplifier. In addition, this point is isolated from the gating pulses that control the switching diodes during dual-trace operation. The pick-off signal is amplified by transistors Q9753 and Q9754 and applied to emitter follower Q9755 through zener diode CR9751.

Zener diode CR9751 is employed to drop the dc level at the base of emitter follower Q9755 to near ground. This is required since with no signal in the amplifier, the trigger amplifier output, with trace screen-centered, should be zero.

The Channel 2 internal TRIG DC LEVEL potentiometer R9711R, is used to set the dc level at the emitter of Q9755 to zero volts. The adjustment is made when no signal is applied to Channel 2 and its trace is centered on the screen.

When using the dual-trace feature of this Plug-in for internal triggering of the time base, always set the TRIG MODE switch to CH 2 ONLY to avoid triggering on the change in dc positioning level between channels. The NORM mode may be used provided

the Time Base Module is set up for ACF or LF REJECT trigger coupling.

Channel 2 trigger amplifier also serves as the output amplifier for Channel 2 input signal when module is set up for high sensitivity amplifier operation. An external connection from CH 2 OUT connector to Channel 1 input connector provides a series connection of Channel 1 and Channel 2 amplifiers. In this mode, the Composite trigger amplifier provides the pick-off signal when using internal triggering. Refer to Section 2, Operation, paragraph 2-12, for further details.

c. Composite Internal Triggering

Operation of the Composite trigger pick-off amplifier is identical to that described for Channel 2 trigger amplifier. However, the derivation of the trigger pickoff signal is different. If both channels are on, the trigger is a composite of successive signals sampled in time, arriving from the *On* channel. Composite internal trigger is available when the TRIGGER switch is set to NORM.

During single-trace operation, the trigger is not time-shared since only one channel is operating. Be that as may, the single channel trigger is still called a composite trigger to distinguish it from the CH 2 ONLY trigger. Naturally, during single-trace operation, the composite trigger will be a replica of the displayed signal of the operating channel.

In dual-trace operation, the composite trigger is comprised of both the ac and dc components of the time-sampled signals from the *On* channels. The dc component is made up from the dc level of the channel's POSITION control, and if the applied signal is dc coupled, this potential is also included.

NOTES

SECTION 4
PERFORMANCE ASSURANCE TEST

4-1. MAINTENANCE CHECK TO ASSURE PERFORMANCE

The tests described in the paragraphs to follow should be performed by Instrument Test Departments and Maintenance Laboratories to certify proper performance. These tests are divided into sections for simplification and to assist those test groups where complete checking is not mandatory, or where all test equipment is not available. Refer to Section 5, paragraph 5-5, for list of test equipment required.

All tests are performed with a representative Type 765H Series Main Frame Oscilloscope and a Y Amplifier Plug-in. Both of the plug-in units must be normalized to the Main Frame before starting tests. This is accomplished by adjusting the front-panel screwdriver SWP CAL and GAIN CAL controls as described in the appropriate plug-in Instruction Manuals. Allow 30 to 60 minutes of warmup time before making any adjustments.

NOTE

If this Plug-in module is checked by a Receiving Inspection laboratory, the tests outlined below are recommended to certify performance. This instrument has been thoroughly tested and aged at the factory. Nevertheless, rough shipment, extreme environments, or long idle periods may necessitate minor adjustments of the controls. Hence, it is suggested that the certifying engineer try the recommended adjustments not only for recentering the controls, but also to ascertain their range and to familiarize himself with this precision instrument. If, after performing all the tests outlined in the paragraphs to follow, the instrument will not perform to specification, the assistance of the local Fairchild Field Engineering representative should be requested.

4-2. CHECKING VERN BALANCE ADJUSTMENT

1. Set VOLTS/DIV switch to 20, Input Selector switch to GND, and rotate VARIABLE control to its minimum gain setting.
2. Adjust the appropriate Time Base plug-in controls for auto and line triggering to obtain a reference trace on the screen.
3. Using the POSITION control on the Type 76-08 Amplifier, position the trace to screen center (reference line).
4. Turn the VARIABLE control to the calibrated position and note any deflection.
5. Adjust the VERN BAL control until the trace is positioned to the reference line established in step 3. Do *not* change the POSITION control setting.
6. Continue to adjust the VERN BAL control until there is no depositioning of the trace when the VARIABLE control is rotated back and forth throughout its range.
7. Repeat above setup (steps 1 through 6) for Channel 2.

Note: If the adjustment range of the front-panel VERN BAL control is insufficient, refer to Section 5, Maintenance and Recalibration, for the complete Coarse and Fine Balance adjustment procedure.

4-3. CHECKING SENSITIVITY OF CHANNELS 1 & 2

1. Set both Channel 1 and Channel 2 VOLTS/DIV switches to CAL and turn both VARIABLE controls to CAL (fully cw).
2. Set both Input Selector switches to (X1) NORM AC (black sector).
3. Set MODE switch to CH 1 and TRIGGER switch to NORM.
4. Adjust Time Base unit for a sweep rate of 10 msec/div and observe 6 cycles of calibrator waveform at 60-cycle line. (5 cycles for 50-cycle line.)
5. Set MODE switch to ALT.
6. Check range of Channel 1 (X1) GAIN ADJ front-panel screwdriver control (labeled black). It should control the amplitude of the calibrator signal over a range from 3.2 to 4.2 divisions peak-to-peak. Set Channel 1 (X1) GAIN ADJ control for 4 divisions of vertical deflection.
7. Position the traces one on top of the other.
8. Adjust Channel 2 (X1) GAIN ADJ control until only one trace may be observed (traces are superimposed).
9. Set Input Selector switch to (X10) NORM AC (green sector) and MODE switch to CH 1.
10. Repeat steps 6 through 8 using (X10) GAIN ADJ control (concentric with POSITION control).

4-4. CHECKING FAST FALL TIME OF CHANNELS 1 & 2

1. Connect a Fairchild Type 791 Square Wave Generator to the Type 76-08 through a 16-db pad and a 50-ohm cable, terminated in Type 4285A 50-ohm pad.
2. Set both Channel 1 and Channel 2 VOLTS/DIV switches to 0.5 and turn both VARIABLE controls to CAL (fully cw).

3. Set both Input Selector switches to (X1) NORM AC (black sector).

4. Set MODE switch to CH 1 and TRIGGER switch to NORM.

5. Set the generator to 1 Mc and observe 4-division peak negative pulse trailing edge on the oscilloscope.

Note: The overshoot, ringing, and preswing should be less than 0.15 division.

Fall time (10% to 90%) should be 8 nanoseconds or less. This includes the fall time of the Type 791 Square Wave Generator.

4-5. CHECKING BANDWIDTH OF CHANNELS 1 & 2

1. Apply 50 Kc output of Boonton Type 82 Constant Amplitude Signal Generator to Y Input connector through a 50-ohm cable, terminated in Type 7093 50-ohm pad.

2. Set Input Selector switch to (X1) NORM AC.

3. Set both VOLTS/DIV switches to 0.5 and turn VARIABLE controls to CAL.

4. Adjust Time Base unit for RECUR sweep of 0.1 usec/div.

5. Adjust test setup for precisely 4 divisions of vertical deflection.

6. Set Generator to high range and set frequency to 50 Mc. The sine wave amplitude at this frequency should have range of 2.5 to 3.1 divisions (nominally 2.8 divisions).

4-6. CHECKING MODE SWITCH

1. On CH 1, check that Channel 1 POSITION potentiometer controls the display.

2. On CH 2, check that Channel 2 POSITION potentiometer controls the display.

3. On ALT, check that CH 1 and CH 2 POSITION potentiometers control their respective displays. Vary the sweep rate from high to low sweep speeds.

4. On CHOP, check that CH 1 and CH 2 POSITION potentiometers control their respective displays.

5. On ADDED, check that either Channel 1 or Channel 2 POSITION potentiometer controls the display.

SECTION 5
MAINTENANCE AND RECALIBRATION

5-1. INTRODUCTION (Figure 5-1)

This section of the Instruction Manual contains service information and procedures for internal adjustments. Refer to Figure 5-1 for an over-all functional block diagram of the Type 76-08 system.

5-2. REMOVAL AND REPLACEMENT OF PARTS

If it is necessary to order a replacement component from the factory, always give the Type Number and Serial Number of the instrument. Before ordering parts for in-warranty replacement or purchasing them for out-of-warranty replacement, be sure to consult the Parts List in this manual. The Parts List gives the values, tolerances, ratings, and the factory part number for all electrical components used in the instrument. This will help to expedite service.

Since your instrument left the factory, some of the parts may have been superseded by improved components. In such cases, the part numbers of these new components will not be listed in your Parts List. However, if you order a part from the factory, and it has been superseded by an improved component, the new part will be shipped in place of the part ordered.

It is the aim of the Fairchild organization to make available the most reliable commercial oscilloscopes within the state of the art and to provide services which will help the user to rapidly restore any of our equipment to its specified performance. Your local Field representative maintains a limited number of spare parts. Also, the factory may be asked to air-ship replacement parts on a rush basis.

5-3. SERVICING HINTS

General maintenance and trouble shooting information is given in the Type 765 Series Oscilloscope Instruction Manual. In the following discussion, it is assumed that you have already read that information and have definitely isolated a trouble in this Plug-in Module.

In trouble-shooting a Plug-in unit, it becomes necessary to determine if the defect is in the plug-in or in the Main Frame of the oscilloscope. The quickest and easiest way of isolating the trouble is to substitute another plug-in unit and determine if the same trouble persists. If the trouble continues after substitution, it can be safely assumed that the defect is in the Main Frame.

There is no simple way of locating troubles. An understanding of the functions of the circuits is the best help. With an understanding of the circuit operation, it will be possible to make a good guess at the general source of troubles from the symptoms. As an aid in trouble shooting this unit, refer to the system block diagram in this Section and also to the schematics.

To keep electronic units operating at top performance, it is desirable to check the equipment at regular intervals. The period between checks will depend on the installation and the conditions of operation. For these regular checks, clean all dust and dirt from the unit using a light air blast or soft brush. However, to insure the reliability of measurements, we suggest that you recalibrate the Plug-in after each 500 hours of operation or every six months if used intermittently. Also, the calibration of a unit should always be fully checked and adjusted after the repair or replacement of any component in the unit. The complete adjustment procedure for this unit is given in this Section of the Instruction Manual.

In the event of improper performance of the Plug-in unit, the following suggestions are recommended:

1. The Type 4294 Extension Cable for remote operation of the plug-in from the oscilloscope is available as an accessory. This plug-in extender will be helpful for routine maintenance and recalibration. Do not use this extension for HF alignments; instead, remove the Main Frame side cover.

2. A Type 766H Test Oscilloscope is recommended fror localizing troubles, especially when servicing a Type 76-08 inserted in a Type 767 Oscilloscope. To check waveforms, use a high-impedance probe while trouble shooting.

3. Maintain a high quality of workmanship. Use a clean bench and soldering iron; keep solder joints smooth and bright; do not overheat any component while soldering. Use heat sinks when soldering semiconductors. The use of a 30-watt iron such as a Hexacon Type 26S is recommended.

4. When using accessory probes or adapters, be sure the trouble is not originating in the accessory before suspecting the instrument itself.

5. Once the defective stage has been localized, the component or components causing the trouble can be located by tube and component substitution or by

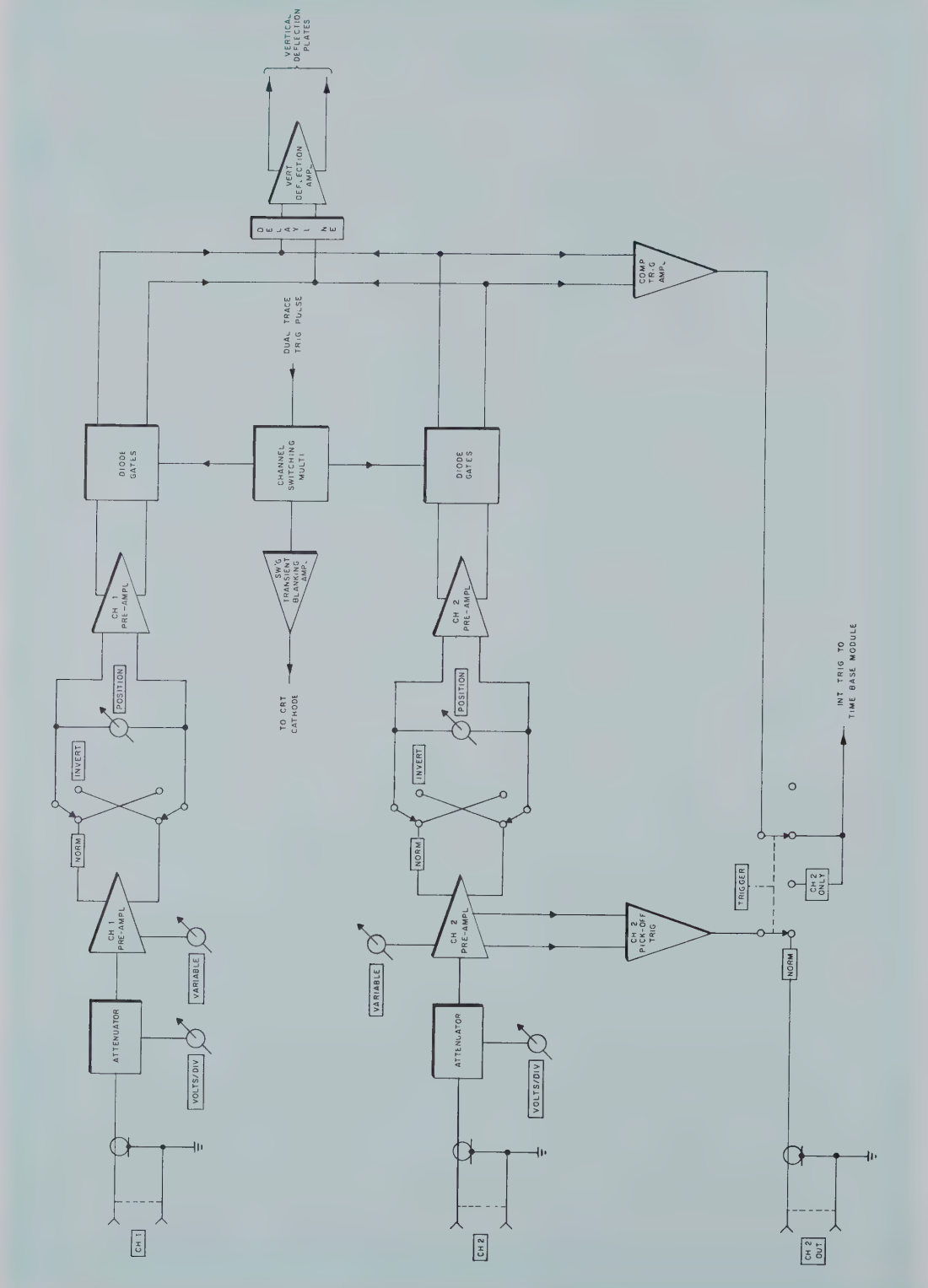


Figure 5-1. Type 76-08 Over-All System Block Diagram

voltage measurement. Key voltage measurements are shown on the over-all schematics at the rear of this manual.

6. Electron tubes, semiconductors, and service adjustments are identified on photographs located in this Section of the manual.

5-4. GAINING ACCESS TO CHASSIS

Since the Plug-in is not contained in its own dust cover, most of the components are readily accessible when the plug-in is removed from the Main Frame. To gain access to the chassis, simply unscrew the knurled thumbscrew at center bottom of unit and pull it free of the Main Frame.

WARNING

WHEN THE PANELS OR PLUG-INS ARE REMOVED FROM THE INSTRUMENT FOR SERVICING, EXERCISE CAUTION WHILE THE POWER IS ON. The lower voltage busses are potentially more dangerous than the cathode-ray tube potential because of the high current capabilities and large filter capacitors employed in these supplies. When you reach into the instrument with one hand while it is turned on, do not grasp the metal frame with the other hand. If possible, stand on an insulated floor and use insulated tools. It is advisable to ground the third lead in the power cord whenever the instrument is in use.

NOTE: Always use insulated tools while working or making adjustments on the unit when power is on. The transistors in this instrument may be damaged if over-voltaged by accidental grounding of one or more elements. Exercise caution and turn off power when making repairs.

5-5. TEST EQUIPMENT REQUIRED FOR SERVICE ADJUSTMENTS

a. Introduction

The adjustments outlined in the following paragraphs are based on the test procedure followed at the factory. All adjustments should be made at mid-line voltage, 115V/230V ±2%.

To set up the Amplifier Plug-in unit for calibration, insert the Amplifier Plug-in and the Time Base Plug-in into the Main Frame. The Time Base Plug-in module and Main Frame must be fully tested and certified units.

b. TEST EQUIPMENT REQUIRED (Equivalent may be substituted)

Equipment	Description
Oscilloscope	Fully certified and tested Type 766H Main Frame
X Plug-In	Type 74-03A
Volt-ohmmeter	Simpson Model 260; 20K ohms/volt sensitivity
Square Wave Generator	Fairchild Type 791
Sine Wave Generator	Boonton Type 82 Constant Amplitude Sine Wave Generator
50-ohm Termination	Fairchild Type 4285A
Capacitance Standardizer	Fairchild Type 7012 (1M, 23 pf)
Extension Cable for Remote Operation of Plug-In	Fairchild Type 4294
Alignment Tools	Fairchild Type 7013 Tool Kit
Pads	GR 20 db (2); GR 10 db (1); GR 6 db (1)

Turn on the power and allow 30 minutes of warm-up time.

5-6. GAS CURRENT COMPENSATION R9210 (R9410)

NOTE

Reference symbols in parenthesis refer to Channel 2.

Undesirable voltages are developed at the grids of V921 and (V941) due to leakage currents. These potentials are nulled by the proper adjustment of the GAS COMP potentiometers R9210 and (R9410). To adjust, proceed as follows:

1. Preset both Channel 1 and Channel 2 front-panel controls as indicated.

Control	Setting
VOLTS/DIV	0.005
VARIABLE	CAL (fully cw)
Input Selector	X10 NORM DC (green sector)
*(X10) GAIN ADJ	fully cw

* Concentric with POSITION control

2. Set up the Time Base controls for automatic triggering.

3. Adjust the GAS COMP potentiometer R9210 for no depositioning of the trace while switching between (X10) NORM DC and (X10) NORM GND.
4. Repeat step 3 for Channel 2 adjusting R9410.

5-7. DC BAL ADJUSTMENT R9201R (R9201F)

If the dc balance of the Type 76-08 Amplifier is not properly adjusted, the reference trace on the screen will be depositioned when the VARIABLE control is rotated. To properly adjust, proceed as follows:

1. Preset both Channel 1 and Channel 2 front-panel controls as indicated.

Control	Setting
Input Selector	(X10) NORM GND (green sector)
VOLTS/DIV	0.05
VARIABLE	fully ccw
VERN BAL	center of range
(X10) GAIN ADJ	fully cw

2. Adjust Time Base controls for automatic triggering.
3. Set MODE switch to CH 1 and position the reference trace to screen center.
4. Adjust COARSE DC BAL potentiometer R9201R for no depositioning of trace while adjusting Channel 1 VARIABLE control from minimum to maximum.
5. Adjust VERN BAL control for no depositioning of trace while adjusting Channel 1 VARIABLE control from minimum to maximum.
6. Repeat steps 3 through 5 for Channel 2 using R9201F, and Channel 2 VARIABLE, POSITION, and VERN BAL controls.

5-8. DC BAL ADJUSTMENT X10 AMPLIFIER R9245 (R9445)

The X10 DC BAL is properly adjusted when there is no depositioning of the trace while switching the Input Selector switch between any (X1) NORM and (X10) NORM positions. To properly adjust, proceed as follows:

1. Set both Channel 1 and Channel 2 VOLTS/DIV switches to 20 and turn both VARIABLE controls to CAL (fully cw).
2. Adjust Time Base controls for automatic triggering and position trace to screen center.
3. Adjust X10 DC BAL potentiometer, R9245 for no depositioning of the trace while switching Channel 1 Input Selector switch between any (X1) NORM and (X10) NORM setting.
4. Repeat step 3 using Channel 2 Input Selector switch and R9445.

5-9. GAIN ADJ (X1 and X10)

Whenever the Type 76-08 Amplifier is removed from the Main Frame and inserted in another, the front-panel screwdriver GAIN ADJ control must be reset. To properly normalize the gain between channels or between the Plug-in unit and the Main Frame, proceed as follows:

1. Set both Channel 1 and Channel 2 VOLTS/DIV switches to CAL and turn both VARIABLE controls to CAL (fully cw).
2. Set both Input Selector switches to (X1) NORM AC (black sector).
3. Set MODE switch to CH 1 and TRIGGER switch to NORM.
4. Adjust the sweep controls for auto and line triggering.
5. Set MODE switch to ALT and adjust sweep rate for 2 milliseconds/divison.
6. Set Channel 1 (X1) GAIN ADJ front-panel screwdriver control (labeled black) for 4 divisions of vertical deflection.
7. Position the traces one on top of the other.
8. Adjust Channel 2 (X1) GAIN ADJ control until only one trace may be observed (traces are superimposed).
9. Set Input Selector switch to (X10) NORM AC (green sector) and MODE switch to CH 1.
10. Repeat steps 6 through 8 using (X10) GAIN ADJ control (concentric with POSITION control).

5-10. TRIG DC LEVEL R9711F (R9711R)

1. With no signal input, adjust the oscilloscope to obtain a trace centered on the screen.
2. Set TRIGGER switch to NORM.
3. Connect a voltmeter between pin 25 of P9001 and ground.
4. Adjust the TRIG DC LEVEL potentiometer R9711F for an indicated reading of zero volts.
5. Set TRIGGER switch to CH 2 ONLY.
6. Repeat step 4 using R9711R. The internal trigger pickoff levels are now properly adjusted.

5-11. HIGH-FREQUENCY ADJUSTMENTS C9516, C9514, C9505, C9209 (C9409), R9242 (R9442) (C9216) (Figure 5-2)

1. Apply the output from a Fairchild Type 791 Square Wave Generator with its SOURCE IMPEDANCE control set to 50 ohms through a RG-8A/U 50-ohm cable terminated in Type 4285A to Channel 1 Input connector on the Type 76-08 unit.
2. Set Input Selector switch to (X1) NORM AC, VOLTS/DIV switch to 0.05, the VARIABLE control to CAL, MODE switch to CH 1, and TRIGGER switch to NORM.
3. Set up Time Base triggering controls for negative SLOPE, LF REJECT coupling and INT source.

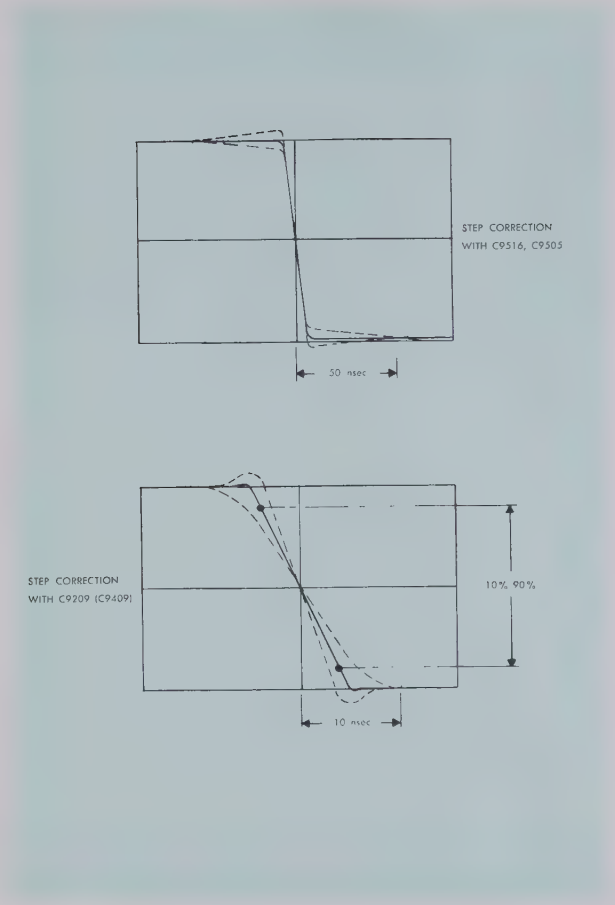


Figure 5-2. Appearance of Waveform When High-Frequency Adjustments Are Correctly Made

4. Set frequency range of the Square Wave Generator to 1 megacycle and adjust its output to give 5 divisions of vertical deflection.

5. Adjust trimmer capacitors C9516, C9514, C9505, C9209 and R9242 for optimum square wave response. See Figure 5-2.

6. Set MODE switch to CH 2.

7. Adjust trimmer capacitor C9409 and R9442 for optimum square wave response. See Figure 5-2.

Note: Do not readjust trimmer C9516, C9514 and C9505.

8. Check fall time of the displayed pulse (10% to 90% points). It should measure less than 8 nanoseconds; if not, readjust C9209 and (C9409) until fall time $\leqq$ 8 nanoseconds. The permissible overshoot and ring should be less than 0.15 division out of 5 divisions. The termination bump should be less than 0.05 division. Align to best possible response, then check to see that the displayed waveform is within that specified in Figure 5-2.

5-12. INPUT CAPACITANCE STANDARDIZATION AND ATTENUATOR ADJUSTMENT (Figures 5-3 and 5-4)

The attenuators are factory aligned and should not be touched unless there is positive indication that they require adjustment. To make these adjustments, the front panel must be removed to gain access to the trimmer capacity. If adjustment is necessary, follow the steps as outlined making reference to Table 5-1. Reference symbols in ( ) pertain to Channel 2.

The input capacitance standardization and attenuator adjustments are interdependent, therefore both tests must be performed in the same procedure. The need for readjustment is normally indicated by distortion of fast-rising waveforms on one or more of the most sensitive ranges of this plug-in unit.

Standardization of the input capacitance of this Y Plug-in unit requires the use of a 23-picofarad Capacitance Standardizer. To properly adjust the input

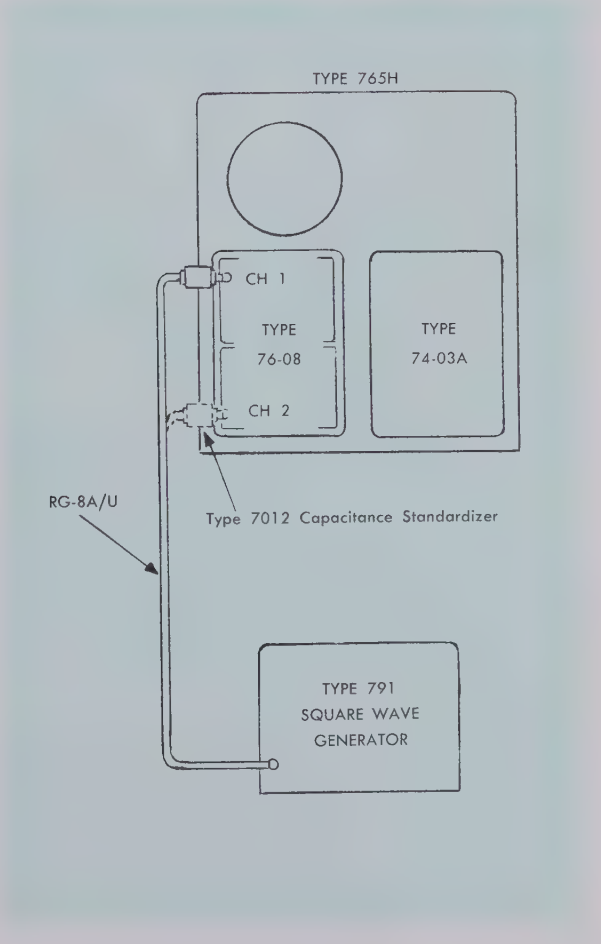


Figure 5-3. Test Setup for Adjusting Input Capacitance

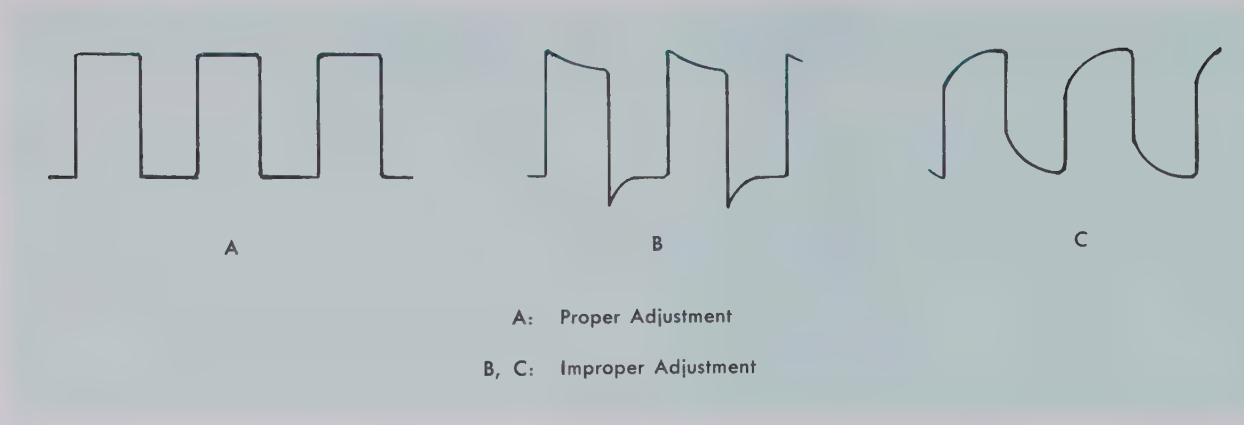


Figure 5-4. Standardizing the Input Capacitance

capacitance and the attenuators of this plug-in unit, proceed as follows:

1. Adjust the trimmer of the Type 7012 Capacitance Standardizer to give 23 pf with a capacitance meter.
2. Connect the Type 7012 directly to Channel 1 Input BNC connector on the Type 76-08 Plug-in.
3. Set the VOLTS/DIV switch to 0.05 and the Input Selector switch to DC.
4. Apply the output from a Fairchild Type 791 Square Wave Generator SOURCE IMPEDANCE switch set to 50 ohms through an RG-8A/U 50-ohm cable, through the 23-picofarad Capacitance Standardizer to the Input connector on the Type 76-08. See Figure 5-3.
5. Set the Square Wave Generator to 5 Kc and adjust the Time Base controls for a display of several cycles.

Note: Always center the square wave display on the cathode-ray tube screen. (Screen and square wave centers should agree within ±1 division or less.)

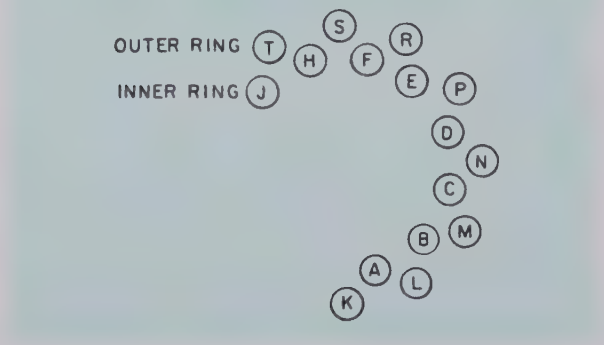


Figure 5-5. Type 76-08 Channel 1 or Channel 2 Trimmer Locations

6. Adjust input trimmer C9115 (C9315) for flat square waves (±0.1 div).
7. Disconnect the 23-picofarad Capacitance Standardizer from the setup and connect the cable to the input BNC connector on the Type 76-08.
8. Set Square Wave Generator to obtain 4 divisions of deflection and adjust the trimmer indicated in Table 5-1 for flat response. See Figure 5-5. At low sensitivity, switch internal impedance of Type 791 Square Wave Generator to 600 ohms.

5-13. CASCADED PRE-AMPLIFIER ADJUSTMENT (C9707) (Figure 5-6)

1. Apply a 100 Kc output from a Fairchild Type 791 Square Wave Generator SOURCE IMPEDANCE switch set to 50 ohms through a 50-ohm cable terminated in a Type 4285A Termination to Channel 2 Input connector. Connect GR pads totaling 56 db (6 db + 10 db + 20 db + 20 db) in series with the cable. See Figure 5-6.
2. Preset front-panel controls as indicated.

Control	Setting
TRIGGER	NORM
MODE	CH 1
CH 1 & CH 2 Input Selector	(X10) NORM AC
CH 1 & CH 2 VOLTS/DIV	0.05
CH 1 & CH 2 VARIABLE	CAL (fully cw)

3. Using the 4" length of RG-58/U cable, interconnect CH 2 OUT panel connector to CH 1 panel connector. The deflection on the screen should be between 5 and 6 divisions peak-to-peak.
4. Adjust trimmer C9707 for flat bottom.

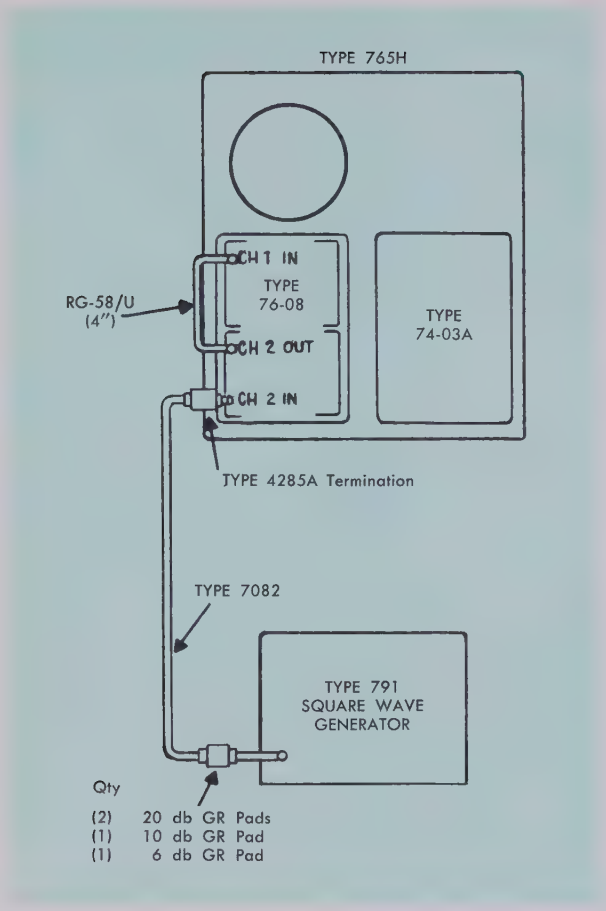


Figure 5-6. Test Setup for Adjusting Trimmer C9707

5-14. X10 HIGH-FREQUENCY ADJUSTMENTS C9213 (C9413)

Trimmers C9213 and C9413 are provided to improve the amplifier performance in the X10 range. These trimmers must be readjusted whenever the Type 76-08 Plug-in is switched from one Main Frame to another. To adjust, proceed as follows:

1. Preset front-panel controls as indicated.

Control	Setting
Input Selector	(X10) NORM AC (green sector)
VOLTS/DIV (both)	0.005
MODE	CH 1
TRIGGER	NORM

2. Apply a 1 megacycle signal from a Fairchild Type 791 Square Wave Generator properly terminated, to Channel 1 Input BNC connector.

3. Set up Time Base triggering controls for negative slope, LF REJECT coupling, and INT source.

4. Adjust Channel 1 trimmer C9213 to optimize the square wave response.

5. Switch the generator to Channel 2 Input and set MODE switch to CH 2.

6. Adjust Channel 2 trimmer C9413 to optimize the square wave response. Check fall time of the displayed pulse (10 % to 90% points). It should measure less than 15 nanoseconds. The permissible overshoot should be less than 0.15 division out of 5 divisions.

TABLE 5-1
ATTENUATOR COMPENSATION TRIMMERS

VOLTS/DIV Setting	Trimmers	Location (Fig. 5-5)
0.1	C9128 (C9328)	K
0.2	C9127 (C9327)	L
0.5	C9123 (C9323)	M
1	C9121 (C9321)	N
2	C9113 (C9313)	P
5	C9111 (C9311)	R
10	C9108 (C9308)	S
20	C9106 (C9306)	T

( ) denotes CH 2

Reconnect the Capacitance Standardizer as per step 2, then continue adjustments given below.

VOLTS/DIV Setting	Trimmers	Location Fig. 5-5)
0.1	C9119 (C9319)	A
0.2	C9118 (C9318)	B
0.5	C9117 (C9317)	C
1	C9116 (C9316)	D
2	C9105 (C9305)	E
5	C9104 (C9304)	F
10	C9103 (C9303)	H
20	C9102 (C9302)	J

( ) denotes CH 2

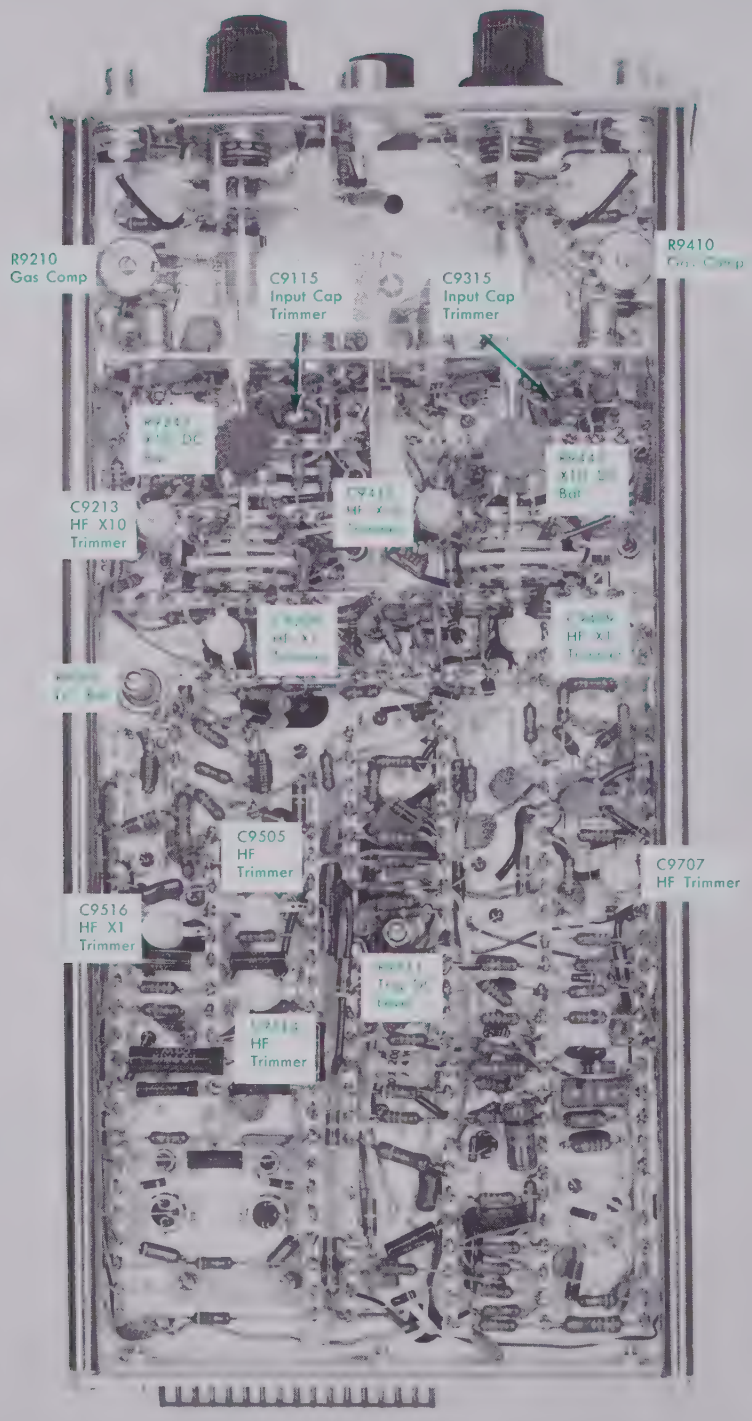


Figure 5-7a. Left Side View Showing Pots and Trimmer Adjustments

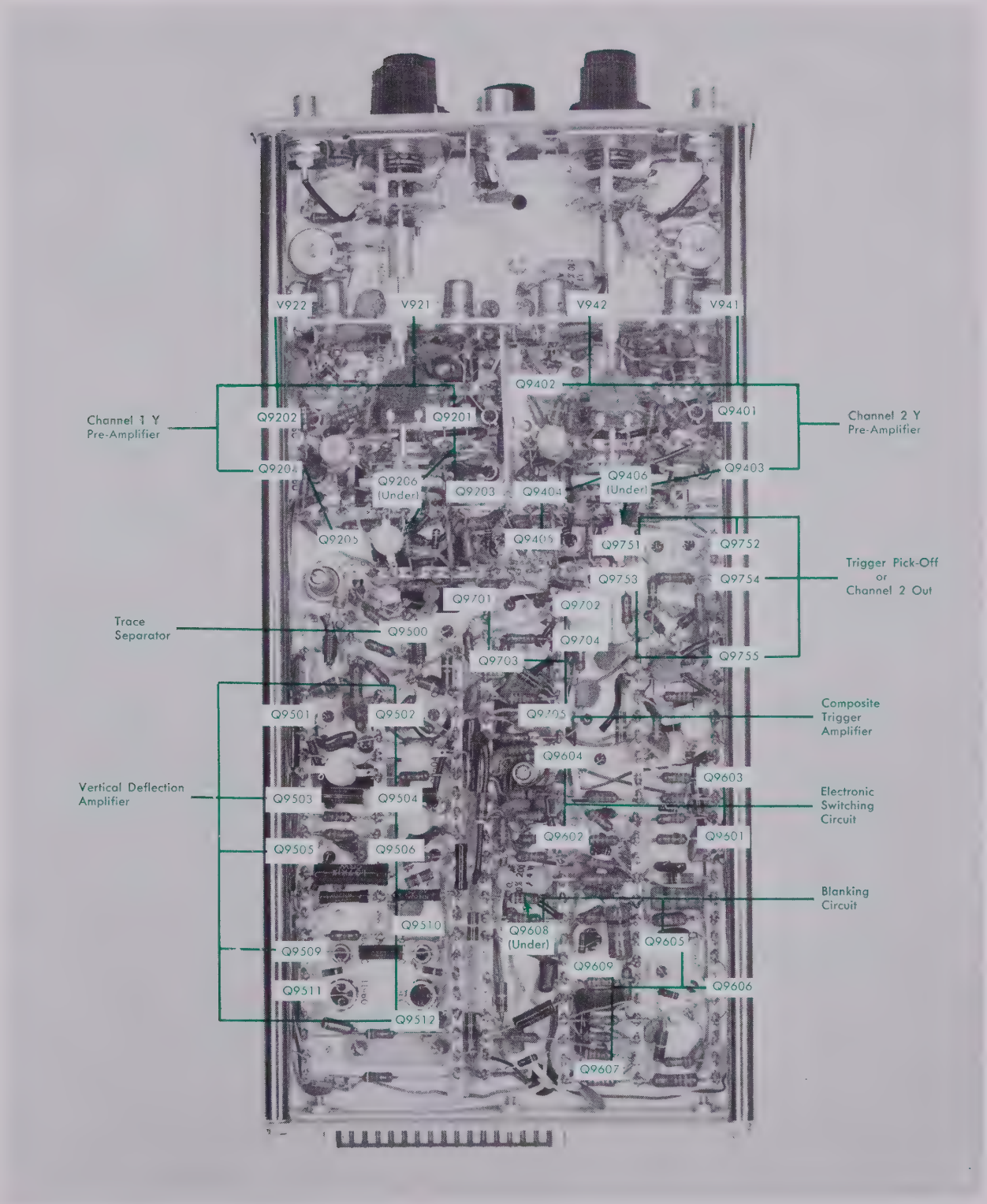


Figure 5-7b. Left Side View Showing Nuvistors and Transistors

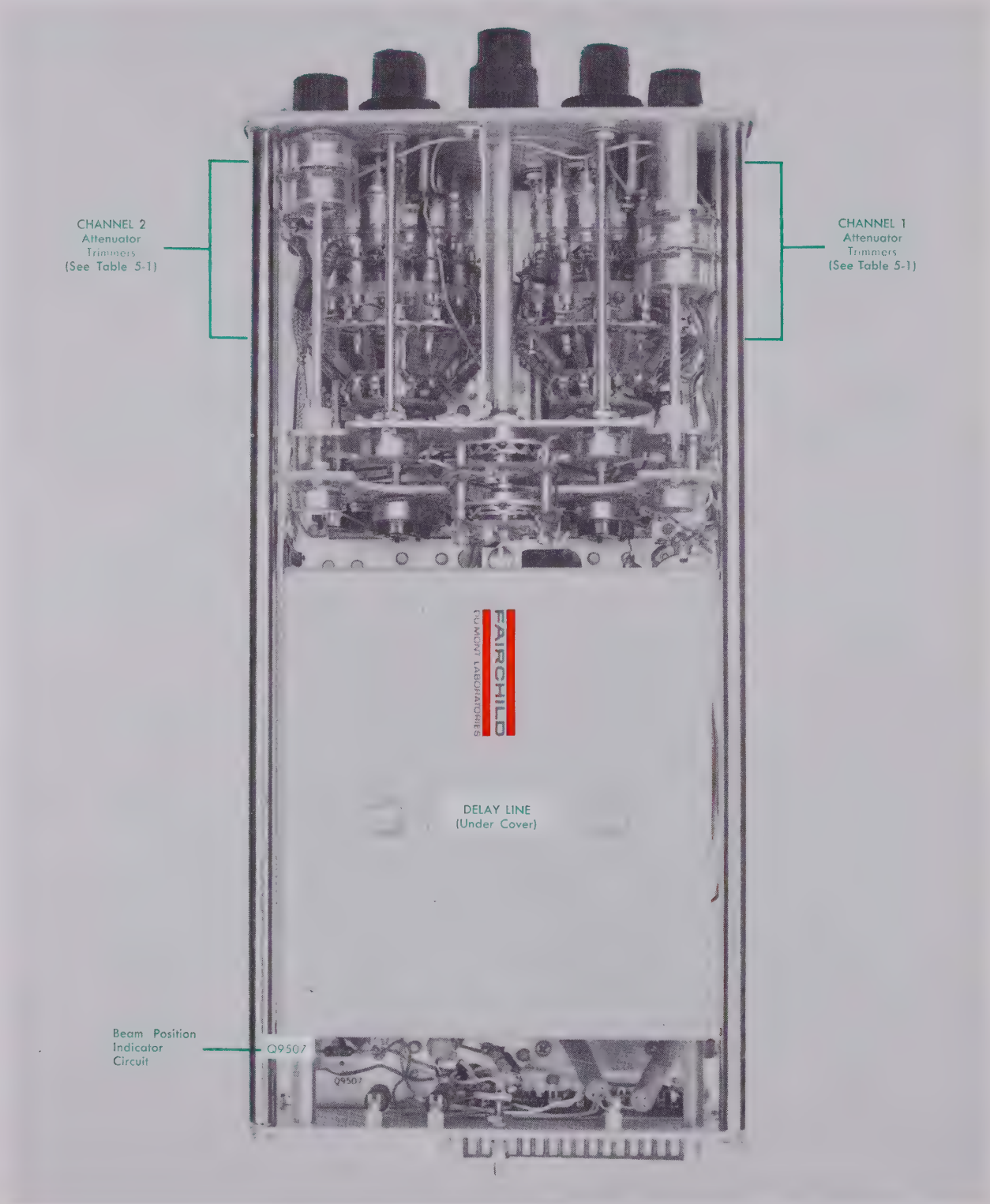


Figure 5-8. Right Side View Showing Transistors and Attenuator Trimmers

NOTES

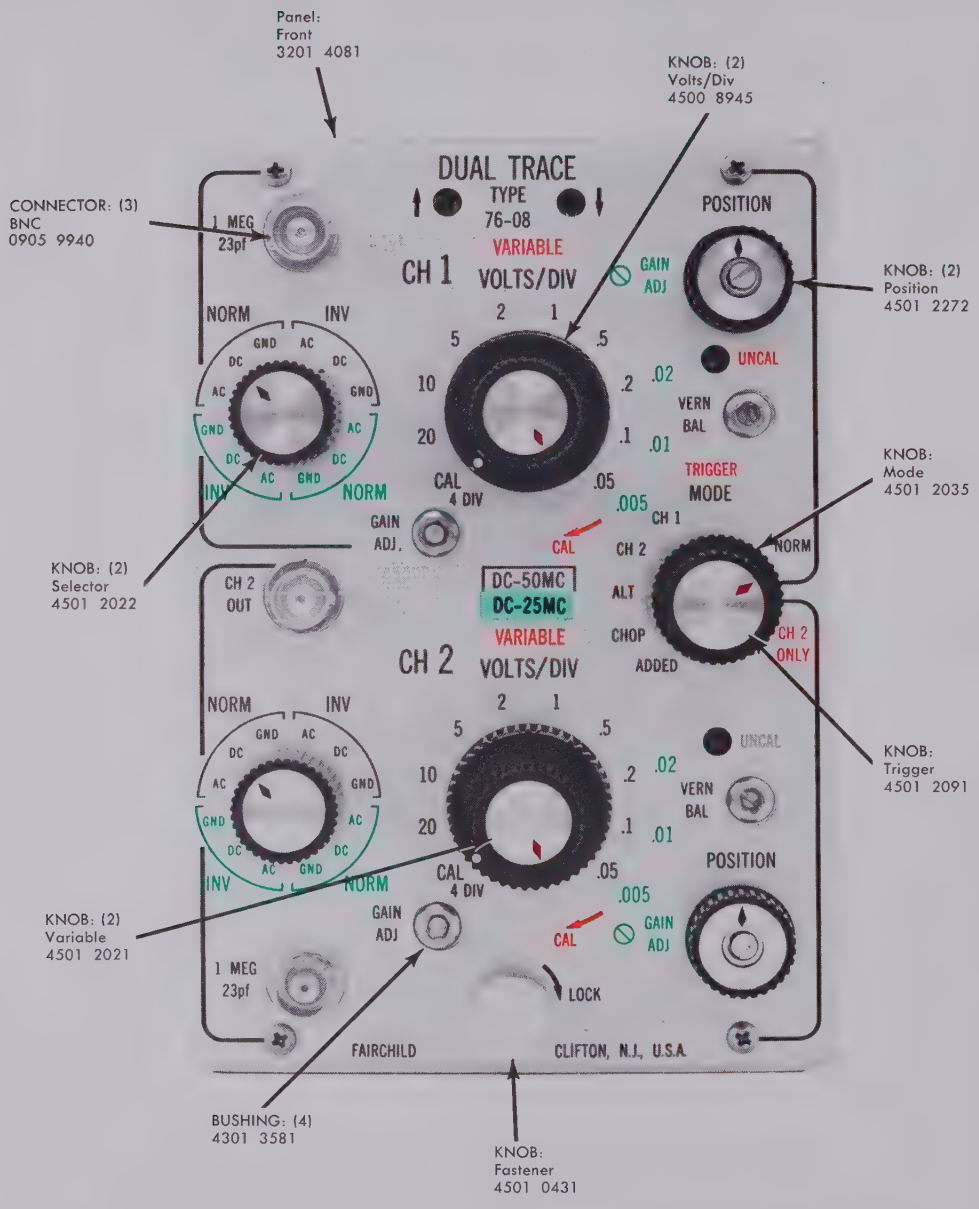


Figure 6-1. Front Panel Replaceable Parts

SECTION 6A
ELECTRICAL PARTS LIST AND SCHEMATICS

TYPE 76-08 PLUG-IN

CAPACITORS

Notes: 1. All capacitors are fixed, ceramic, ±10%, and 500V unless otherwise specified; pf (μμf) denotes picofarads.

2. GMV denotes Guaranteed Minimum Value.

Symbol	Part Number	Description	Recommended Vendor Code	Type
C9100	0326 4520	1000 pf, GMV	ERC	
C9101	0327 2370	plastic, 0.01 μf, 600V	GDE	663UW
C9102 to				
C9105	0327 2110	variable, 2-12 pf	CTC	CST50
C9106	0319 1258	variable, 0.65-3.2 pf	ABD	
C9107	0326 3040	mica, 750 pf	ERC	370CB
C9108	0319 1258	variable, 0.65-3.2 pf	ABD	
C9109	0313 9740	mica, 500 pf	ERC	370CB
C9111	0319 1258	variable, 0.65-3.2 pf	ABD	
C9112	0313 9750	mica, 250 pf	ERC	370CB
C9113	0319 1258	variable, 0.65-3.2 pf	ABD	
C9114	0313 9730	mica, 100 pf	ERC	370CB
C9115	0319 1258	variable, 0.65-3.2 pf	ABD	
C9116 to				
C9119	0327 2110	variable, 2-12 pf	CTC	CST50
C9121	0319 1258	variable, 0.65-3.2 pf	ABD	
C9122	0313 9790	mica, 22 pf	ERC	370CB
C9123	0319 1258	variable, 0.65-3.2 pf	ABD	
C9124	0313 9700	mica, 15 pf	ERC	370CB
C9125	0316 7160	3.3 pf, ±0.25 pf	ERC	NPO-331
C9126	0316 7370	15 pf, ±5%	ERC	NPO-331
C9127 &				
C9128	0319 1258	variable, 0.65-3.2 pf	ABD	
C9200	0326 4520	1000 pf, GMV	ERC	
C9201	0326 4620	5000 pf, GMV	ERC	
C9202 to				
C9204	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9205	0316 7160	3.3 pf, ±0.25 pf	ERC	NPO-331
C9206 &				
C9207	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9208	0315 1530	33 pf	ERC	NPO-338
C9209	0326 9480	variable, 9-35 pf, 100V	ERC	538
C9210	0315 2140	22 pf, ±10%, 500V	RMC	C
C9211	0317 5240	mica, 68 pf, ±5%	EMC	DM15
C9212	0317 5130	mica, 27 pf, ±5%	EMC	DM15
C9213	0326 9480	variable, 9-35 pf, 100V	ERC	538
C9214	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9215	0313 3870	composition, 2.2 pf	STC	GA
C9216	0326 9510	variable 2.5-11 pf	ERC	538
C9300	0326 4520	1000 pf, GMV	ERC	
C9301	0327 2370	plastic, 0.01 μf, 600V	GDE	663UW
C9302 to				
C9305	0327 2110	variable, 2-12 pf	CTC	CST50
C9306	0319 1258	variable, 0.65-3.2 pf	ABD	
C9307	0326 3040	mica, 750 pf	ERC	370CB
C9308	0319 1258	variable, 0.65-3.2 pf	ABD	
C9309	0313 9740	mica, 500 pf	ERC	370CB
C9311	0319 1258	variable, 0.65-3.2 pf	ABD	
C9312	0313 9750	mica, 250 pf	ERC	370CB
C9313	0319 1258	variable, 0.65-3.2 pf	ABD	
C9314	0313 9730	mica, 100 pf	ERC	370CB
C9315	0319 1258	variable, 0.65-3.2 pf	ABD	
C9316 to				
C9319	0327 2110	variable, 2-12 pf	CTC	CST50
C9321	0319 1258	variable, 0.65-3.2 pf	ABD	
C9322	0313 9790	mica, 22 pf	ERC	370CB
C9323	0319 1258	variable, 0.65-3.2 pf	ABD	
C9324	0313 9700	mica, 15 pf	ERC	370CB
C9325	0316 7160	3.3 pf, ±0.25 pf	ERC	NPO-331
C9326	0316 7370	15 pf, ±5%	ERC	NPO-331
C9327 &				
C9328	0319 1258	variable, 0.65-3.2 pf	ABD	
C9400	0326 4520	1000 pf, GMV	ERC	
C9401	0326 4620	5000 pf, GMV	ERC	
C9402 &				
C9403	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9404	0326 7860	plastic, 0.1 μf, ±10%, 200V	AMX	C296AB
C9406 &				
C9407	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9408	0315 1530	33 pf	ERC	NPO-338
C9409	0326 9480	variable, 9-35 pf, 100V	ERC	538
C9411	0317 5240	mica, 68 pf, ±5%	EMC	DM15
C9412	0317 5130	mica, 27 pf, ±5%	EMC	DM15
C9413	0326 9480	variable, 9-35 pf, 100V	ERC	538
C9414	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9415	0313 3870	composition, 2.2 pf	STC	GA
C9416	0316 7280	10 pf	ERC	NPO-331
C9502 &				
C9503	0313 3680	composition, 5.6 pf, ±5%	JEF	JM5/32
C9504	0326 4520	1000 pf, GMV	ERC	
C9505	0326 9500	variable, 5.5-18 pf, 200V	ERC	538
C9507	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9508	0326 4520	1000 pf, GMV	ERC	
C9509	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9510	0317 5890	mica, 270 pf, ±5%	EMC	DM15
C9511 &				
C9512	0326 4520	1000 pf, GMV	ERC	
C9513	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9514	0317 5230	mica, 62 pf	ERC	538
C9515	0317 7070	mica, 820 pf	EMC	DM20
C9516	0326 9480	variable, 9-35 pf, 100V	ERC	538
C9518 &				
C9519	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9521	0326 9330	0.47 μf, ±20%, 50V	SPG	No. 5054
C9528 &				
C9529	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9601	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9602	0317 5150	mica, 33 pf, ±5%	EMC	DM15
C9603	0317 5090	mica, 18 pf, ±5%	EMC	DM15
C9604 to				
C9606	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9607	0317 5090	mica, 18 pf, ±5%	EMC	DM15
C9608	0317 5150	mica, 33 pf, ±5%	EMC	DM15
C9609	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9610	0316 7050	51 pf, ±5%	ERC	NPO-338
C9651	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9652	0317 6690	mica, 560 pf, ±5%	EMC	DM20
C9653 &				
C9654	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9656	0317 5290	mica, 110 pf, ±5%	EMC	DM15
C9657 &				
C9658	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9659	0326 7860	plastic, 0.1 μf, 200V	AMX	C296AB
C9661	0317 5350	mica, 200 pf, ±5%	EMC	DM15
C9662	0316 7280	10 pf, ±5%	ERC	NPO-331
C9663	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9701	0327 1340	0.22 μf, ±20%, 50V	SPG	5C52
C9702 to				
C9706	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9707	0326 9490	variable, 2-8 pf, 200V	ERC	538
C9751	0327 1340	0.22 μf, ±20%, 50V	SPG	5C52
C9752 to				
C9755	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9756	0326 7650	electrolytic, 50 μf +100 −10%, 50V	SPG	30D200A1
C9757	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM
C9802	0326 7860	plastic, 0.1 μf, 200V	AMX	C296AB
C9803 to				
C9807	0319 1050	0.02 μf, +60 −40%, 150V	CRL	DDM

Symbol	Part Number	Description	Recommended Vendor Code	Type
SEMICONDUCTORS				
CR9201 to CR9204	2600 6910	diode, FD841	FCI	
CR9401 to CR9404	2600 6910	diode, FD841	FCI	
CR9601 to CR9604	2600 6910	diode, FD841	FCI	
CR9606	2600 6910	diode, FD841	FCI	
CR9651 to CR9654	2600 6910	diode, FD841	FCI	
CR9701	2600 8110	semiconductor, 1N728	HOF	
CR9751	2600 8110	semiconductor, 1N728	HOF	
DELAY LINE				
DL9501	8800 2401	9 ft. 10 ins.	ABD	
LAMPS				
DS9201	1200 3960	glow, neon, NE-2 (UNCAL)	GE	NE-2
DS9401	1200 3960	glow, neon, NE-2 (UNCAL)	GE	NE-2
DS9501 & DS9502	1201 2350	light, indicator, neon	SIG	T2 27 1R10
HYBRID COILS				
HY9101	2110 1560	bead, ferrite	FER	56 590 65/3B
HY9201 & HY9202	2110 1560	bead, ferrite	FER	56 590 65/3B
HY9203	2110 1560	bead, ferrite	FER	56 590 65/3B
HY9205 to HY9208	2110 1560	bead, ferrite	FER	56 590 65/3B
HY9301	2110 1560	bead, ferrite	FER	56 590 65/3B
HY9401 & HY9402	2110 1560	bead, ferrite	FER	56 590 65/3B
HY9403	2110 1560	bead, ferrite	FER	56 590 65/3B
HY9405 & HY9406	2110 1560	bead, ferrite	FER	56 590 65/3B
HY9407 & HY9408	2110 1560	bead, ferrite	FER	56 590 65/3B
HY9700 to HY9702	2110 1560	bead, ferrite	FER	56 590 65/3B
HY9751 & HY9752	2110 1560	bead, ferrite	FER	56 590 65/3B
HY9805 & HY9806	2110 1560	bead, ferrite	FER	56 590 65/3B
ELECTRICAL CONNECTORS				
J9101	0905 9940	receptacle, rf, female, 1 contact, BNC (CH 1 INPUT)	DAG	UG625A/U
J9301	0905 9940	receptacle, rf, female, 1 contact, BNC (CH 2 INPUT)	DAG	UG625A/U
J9701	0905 9940	receptacle, rf, female, 1 contact, BNC (CH 2 OUT)	DAG	UG625A/U
P9001	0905 7340	plug, male, 32 contacts	APH	26 159 32
COILS				
L9801	2100 6300	fixed, rf, 3.3 μh, ±10%	SWW	D10610
TRANSISTORS				
Q9201 & Q9202	2600 8190	DU #14A	FCI	
	2600 8170	alternate, 2N2369		
Q9203 to Q9206	2600 7700	DU #12A	FCI	
	2600 7680	alternate, 2N709		
Q9207 & J9208	2600 7070	DU #2A	FCI	
	2600 7050	alternate, 2N915		
Q9401 & Q9402	2600 8190	DU #14A	FCI	
	2600 8170	alternate, 2N2369		
Q9403 to Q9406	2600 7700	DU #12A	FCI	
	2600 7680	alternate, 2N709		

Symbol	Part Number	Description	Recommended Vendor Code	Type
Q9500	2600 7070	DU #2A	FCI	
	2600 7050	alternate, 2N915	FCI	
Q9501 & Q9502	2600 7070	DU #2A	FCI	
	2600 7050	alternate, 2N915	FCI	
Q9503 & Q9504	2600 8190	DU #14A	FCI	
	2600 8170	alternate, 2N2369		
Q9505 & Q9506	2600 8200	DU #14B	FCI	
	2600 8170	alternate, 2N369		
Q9507	2600 7370	DU #8A/2N699B	FCI	
	2600 7250	alternate, 2N1893		
Q9509 & Q9510	2600 8410	DU #28A	FCI	
	2600 8390	alternate, 2N3013		
Q9511 & Q9512	2600 2791	2N2218	ABD	
Q9601 & Q9602	2600 7020	DU #1A	FCI	
	2600 7000	alternate, 2N914		
Q9603 & Q9604	2600 7020	DU #1A	FCI	
	2600 7000	alternate, 2N914		
Q9605 & Q9606	2600 7020	DU #1A	FCI	
	2600 7000	alternate, 2N914		
Q9607 & Q9608	2600 7070	DU #2A	FCI	
	2600 7050	alternate, 2N915		
Q9609	2600 7170	DU #4A	FCI	
	2600 7150	alternate, 2N1132		
Q9701 & Q9702	2600 7070	DU #2A	FCI	
	2600 7050	alternate, 2N915		
Q9703 & Q9704	2600 7120	DU #3A	FCI	
	2600 7100	alternate, 2N917		
Q9705	2600 7070	DU #2A	FCI	
	2600 7050	alternate, 2N915		
Q9751 & Q9752	2600 7070	DU #2A	FCI	
	2600 7050	alternate, 2N915		
Q9753 & Q9754	2600 7120	DU #3A	FCI	
	2600 7100	alternate, 2N917		
Q9755	2600 7070	DU #2A	FCI	
	2600 7050	alternate, 2N915		

RESISTORS

Note: All resistors are fixed, film, ±5%, and ½W. Values are in ohms unless otherwise specified; K = thousand, M = million.

R9100	0236 6750	13K, ±1%	CGW	NS20
R9101	0203 1530	composition, 10, ±10%	ALB	EB
R9102	0236 7830	174K, ±1%	CGW	N20
R9103	0229 9290	590K, ±1%	TEX	CD1/2PR
R9104	0229 9160	997.5K, ±1%	TEX	CD1/2PR
R9105	0229 4880	2510, ±1%	TEX	CD1/2PR
R9106	0229 9020	995K, ±1%	TEX	CD1/2PR
R9107	0229 4870	5030, ±1%	TEX	CD1/2PR
R9108	0229 9010	990K, ±1%	TEX	CD1/2PR
R9109	0229 9080	10.1K, ±1%	TEX	CD1/2PR
R9111	0229 9000	975K, ±1%	TEX	CD1/2PR
R9112	0229 9070	25.6K, ±1%	TEX	CD1/2PR
R9113	0229 4700	1M, ±1%	TEX	CD1/2PR
R9114	0229 4920	950K, ±1%	TEX	CD1/2PR
R9115	0229 9060	52.6K, ±1%	TEX	CD1/2PR
R9116	0229 4910	900K, ±1%	TEX	CD1/2PR
R9117	0229 9050	111K, ±1%	TEX	CD1/2PR
R9118	0229 4900	750K, ±1%	TEX	CD1/2PR
R9119	0229 9040	333K, ±1%	TEX	CD1/2PR
R9121	0229 4890	500K, ±1%	TEX	CD1/2PR
R9122	0229 4700	1M, ±1%	TEX	CD1/2PR
R9200	0234 8610	47K	CGW	C20
R9201 F/R	0107 2832	variable, 1M/1M, ±20%, ¼W	ALB	
R9202	0109 2060	variable, composition, 1M, ±20%, 0.2W (DC BAL FINE)	CTS	70
R9203	0235 5090	composition, 100K, ¼W	ALB	CB
R9204	0236 3180	470K	ALB	CB
			ALB	CB
R9206	0235 6410	composition, 4.7M, ±10%, ¼W	ALB	CB
R9207	0235 6090	composition, 10K, ±10%, ¼W	ALB	CB

Symbol	Part Number	Description	Recommended Vendor Code	Type
R9208	0235 5810	composition, 47, ±10%, ¼W	ALB	CB
R9209	0235 0760	6.8K, ±2%	CGW	C20
R9210	0109 3080	variable, composition, 10K, ±20%, ¼W (GAS COMP)	CTS	PE200RE
R9211	0235 5810	47, ±10%, ¼W	ALB	CB
R9212 & R9213	0235 0340	120, ±2%	CGW	C20
R9214	0235 0690	3.6K, ±2%	CGW	C20
R9215	0234 8610	47K	CGW	C20
R9216 & R9217	0235 0480	470, ±2%	CGW	C20
R9218 & R9219	0235 0740	5.6K, ±2%	CGW	C20
R9220	0204 2300	composition, 91M, ±20%	IRC	GBT1/2
R9221	0235 0650	2.4K, ±2%	CGW	C20
R9222 & R9223	0235 0810	11K, ±2%	CGW	C20
R9224	0107 2655	variable, 250, ±20%, ¼W (GAIN ADJ)	ABD	
R9226	0107 2843	variable, composition, 250, ±20%, ¼W (VARIABLE)	ABD	
R9227	0203 2030	composition, 150K, ±10%	ALB	EB
R9228 & R9229	0203 0320	100, ±2%	CGW	C20
R9230	0234 8380	5.1K	CGW	C20
R9231	0235 0610	1.6K, ±2%	CGW	C20
R9232	0234 8280	2K	CGW	C20
R9233 F/R	0107 3024	variable, composition, 10K/10K, ±10%, 5W (POSITION)	ABD	
R9234	0234 8280	2K	CGW	C20
R9235	0235 8470	12K	CGW	C20
R9236 & R9237	0234 0390	28, ±1%, ¼W	TEX	CD1/4R
R9238	0235 2190	820, ±2%, 1W	CGW	C32
R9239	0234 8550	27K	CGW	C20
R9240	0235 0390	200, ±2%	CGW	C20
R9241	0234 8550	27K	CGW	C20
R9242	0109 3570	variable, composition, 100, 0.1W	CRL	601-1
R9243	0236 4050	20, ±1%	CGW	NS20
R9244	0235 0490	510, ±2%	CGW	C20
R9245	0109 2390	variable, composition, 250, ±20%, ⅛W (DC LEVEL X10)	CTS	U201
R9246	0235 0490	510, ±2%	CGW	C20
R9247	0109 2520	variable, composition, 1K, ±20%, ¼W (GAIN ADJ X10)	CTS	200
R9248	0234 7930	68	CGW	C20
R9300	0236 6750	13K, ±1%	CGW	NS20
R9301	0203 1530	composition, 10, ±10%	ALB	EB
R9302	0236 7830	174K, ±1%	CGW	N20
R9303	0229 9290	590K, ±1%	TEX	CD1/2PR
R9304	0229 9160	997.5K, ±1%	TEX	CD1/2PR
R9305	0229 4880	2510, ±1%	TEX	CD1/2PR
R9306	0229 9020	995K, ±1%	TEX	CD1/2PR
R9307	0229 4870	5030, ±1%	TEX	CD1/2PR
R9308	0229 9010	990K, ±1%	TEX	CD1/2PR
R9309	0229 9080	10.1K, ±1%	TEX	CD1/2PR
R9311	0229 9000	975K, ±1%	TEX	CD1/2PR
R9312	0229 9070	25.6K, ±1%	TEX	CD1/2PR
R9313	0229 4700	1M, ±1%	TEX	CD1/2PR
R9314	0229 4920	950K, ±1%	TEX	CD1/2PR
R9315	0229 9060	52.6K, ±1%	TEX	CD1/2PR
R9316	0229 4910	900K, ±1%	TEX	CD1/2PR
R9317	0229 9050	111K, ±1%	TEX	CD1/2PR
R9318	0229 4900	750K, ±1%	TEX	CD1/2PR
R9319	0229 9040	333K, ±1%	TEX	CD1/2PR
R9321	0229 4890	500K, ±1%	TEX	CD1/2PR
R9322	0229 4700	1M, ±1%	TEX	CD1/2PR
R9400	0234 8610	47K	CGW	C20
R9402	0109 2060	variable, composition, 1M, ±20%, 0.2W (VERN BAL)	CTS	70
R9403	0235 5090	100K, ¼W	ALB	CB
R9404	0235 6330	composition, 1M, ±10%, 1/4W	ALB	CB
R9406	0235 6410	composition, 4.7M, ±10%, ¼W	ALB	CB
R9407	0235 6090	10K, ±10%, ¼W	ALB	CB
R9408	0235 5810	composition, 47, ±10%, ¼W	ALB	CB
R9409	0235 0760	6.8K, ±2%	CGW	C20
R9410	0109 3080	variable, composition, 10K, ±20%, ¼W (GAS COMP)	CTS	PE200RE
R9411	0235 5810	composition, 47, ±10%, ¼W	ALB	CB
R9412 & R9413	0235 0340	120, ±2%	CGW	C20
R9414	0235 0690	3.6K, ±2%	CGW	C20
R9415	0234 8610	47K	CGW	C20
R9416 & R9417	0235 0480	470, ±2%	CGW	C20
R9418 & R9419	0235 0740	5.6K, ±2%	CGW	C20
R9420	0204 2300	composition, 91M, ±20%	IRC	GRT1/2
R9421	0235 0650	2.4K, ±2%	CGW	C20
R9422 & R9423	0235 0810	11K, ±2%	CGW	C20
R9424	0107 2655	variable, 250, ±20%, ¼W (GAIN ADJ)	ABD	
R9426	0107 2843	variable, composition, 250, ±20%, ¼W (VARIABLE)	ABD	
R9427	0203 2030	composition, 150K, ±10%	ALB	EB
R9428 & R9429	0235 0320	100, ±2%	CGW	C20
R9430	0234 7970	100	CGW	C20
R9431	0235 0610	1.6K, ±2%	CGW	C20
R9432	0234 8280	2K	CGW	C20
R9433 F/R	0107 3023	variable, composition, 10K/10K, ±10%, 5W (POSITION)	ABD	
R9434	0234 8280	2K	CGW	C20
R9435	0234 7970	100	CGW	C20
R9436 & R9437	0234 0390	28, ±1%, ¼W	TEX	CD1/4R
R9438	0235 2190	820, ±2%, 1W	CGW	C32
R9439	0234 8550	27K	CGW	C20
R9441	0234 8550	27K	CGW	C20
R9442	0109 3570	variable, composition, 100, 0.1W	CRL	601-1
R9443	0236 4050	20, ±1%	CGW	NS20
R9444	0235 0490	510, ±2%	CGW	C20
R9445	0109 2390	variable, composition, 250, ±20%, ⅛W (DC LEVEL X10)	CTS	U201
R9446	0235 0490	510, ±2%	CGW	C20
R9447	0109 2520	variable, composition, 1K, ±20%, ¼W (GAIN ADJ X10)	CTS	200
R9448	0234 7930	68	CGW	C20
R9501	0203 1130	composition, 510K	ALB	EB
R9502	0234 8550	27K	CGW	C20
R9503 & R9504	0235 0320	100, ±2%	CGW	C20
R9505	0235 5930	composition, 470, ±10%, ¼W	ALB	CB
R9506	0203 2790	composition, 75K, ±10%	ALB	EB
R9507	0235 5930	composition, 470, ±10%, ¼W	ALB	CB
R9508	0235 2180	750, ±2%, 1W	CGW	C32
R9509	0235 2170	680, ±2%, 1W	CGW	C32
R9510	0234 8450	10K	CGW	C20
R9511	0203 2790	composition, 75K, ±10%	ALB	EB
R9512 & R9513	0234 8450	10K	CGW	C20
R9514	0234 8300	2.4K	CGW	C20
R9515	0234 7900	51	ALB	CB
R9516 & R9517	0236 6380	5.36K, ±1%	CGW	NS20
R9518 & R9519	0234 8110	390	CGW	C20
R9520	0234 8130	470		
R9521	0234 8470	12K	CGW	C20
R9522 & R9523	0236 4600	75, ±1%	CGW	N20
R9524	0234 8400	6.2K	CGW	C20
R9525	0234 8470	12K	CGW	C20
R9526	0109 3600	variable, composition, 1K, 0.1W		
R9527 & R9528	0234 8570	33K	CGW	C20
R9529	0237 8560	1.37K, ±1%, 1W	IRC	CES
R9530	0234 8440	9.1K	CGW	C20
R9531 & R9532	0236 5530	698, ±1%	CGW	NS20

Symbol	Part Number	Description	Recommended Vendor Code	Type
R9533	0203 1610	composition, 47, ±10%	ALB	EB
R9534	0236 5390	499, ±1%	CGW	C20
R9535	0234 8390	5.6K	CGW	C20
R9536	0236 5390	499, ±1%	CGW	C20
R9537	0235 5810	composition, 47, ±10%, ¼W	ALB	CB
R9538	0203 1610	composition, 47, ±10%	ALB	EB
R9539	0230 4170	768, ±1%, 4W	CGW	SI30
R9540	0234 8120	430	CGW	C20
R9541	0230 4170	768, ±1%, 4W	CGW	SI30
R9542	0236 4730	102, ±1%	CGW	C20
R9544	0234 4010	390, ±2%, 7W	CGW	LP15
R9546	0234 4010	390, ±2%, 7W	CGW	LP15
R9547 & R9548	0203 1610	composition, 47, ±10%	ALB	EB
R9549 & R9550	0203 0000	composition, 10	ALB	EB
R9551	0234 8620	51K	CGW	C20
R9552	0234 8600	43K	CGW	C20
R9553	0234 8330	3.3K	CGW	C20
R9554	0203 2040	composition, 180K, ±10%	ALB	EB
R9556	0203 2040	composition, 180K, ±10%	ALB	EB
R9557 & R9558	0235 6090	composition, 10K, ±10%, ¼W	ALB	EB
R9601	0203 1530	composition, 10, ±10%	ALB	EB
R9602	0234 8280	2K	CGW	C20
R9603	0234 8600	43K	CGW	C20
R9604	0234 8330	3.3K	CGW	C20
R9605	0203 1530	composition, 10, ±10%	ALB	EB
R9606 & R9607	0234 8510	18K	CGW	C20
R9608	0234 8990	560, 1W	CGW	C32
R9609	0234 8270	1.8K	CGW	C20
R9610	0234 8500	16K	CGW	C20
R9611	0234 8120	430	CGW	C20
R9612	0234 8330	3.3K	CGW	C20
R9613 & R9614	0234 8510	18K	CGW	C20
R9615	0234 8470	12K	CGW	C20
R9616	0234 8280	2K	CGW	C20
R9617	0234 8600	43K	CGW	C20
R9618	0203 1890	composition, 10K, ±10%	ALB	EB
R9619	0234 8120	430	CGW	C20
R9620	0234 8470	12K	CGW	C20
R9651	0234 8960	composition, 430, 1W	CGW	C20
R9652	0237 0830	1K, 2W	CGW	C42S
R9653	0234 8530	22K	CGW	C20
R9654	0234 8310	2.7K	CGW	C20
R9655	0203 1650	composition, 100, ±10%	ALB	EB
R9656	0203 1530	composition, 10, ±10%	ALB	EB
R9657	0234 8570	33K	CGW	C20
R9658	0234 9140	2.4K, 1W	CGW	C32
R9659	0234 8170	680	CGW	C20
R9661	0234 8570	33K	CGW	C20
R9662	0234 8310	2.7K	CGW	C20
R9663	0237 0830	1K, 2W	CGW	C42S
R9664	0234 8380	5.1K	CGW	C20
R9666	0234 8530	22K	CGW	C20
R9667	0234 8500	16K	CGW	C20
R9668	0234 8430	8.2K	CGW	C20
R9669	0203 0160	composition, 47	ALB	EB
R9671	0234 8340	3.6K	CGW	C20
R9672	0234 8390	5.6K	CGW	C20
R9673	0234 8490	15K	CGW	C20
R9674	0234 7900	51	CGW	C20
R9676	0234 9110	1.8K, 1W	CGW	C32
R9677	0236 0690	24.9K, ±1%	CGW	N120
R9678	0235 9600	2.49K, ±1%	CGW	N120
R9679	0234 8370	4.7K	CGW	C20
R9681	0234 8540	24K	CGW	C20
R9682	0234 8370	4.7K	CGW	C20
R9683	0234 8630	56K	CGW	C20
R9684	0234 8210	1K	CGW	C20
R9701 & R9702	0234 8450	10K	CGW	C20
R9703	0234 7990	120	CGW	C20
R9704	0234 8380	5.1K	CGW	C20
R9705	0234 8290	2.2K	CGW	C20
R9706	0234 8380	5.1K	CGW	C20
R9707 & R9708	0234 8210	1K	CGW	C20
R9709	0234 8610	47K	CGW	C20
R9711 F/R	0107 2831	variable, 1K/1K, ±20% (TRIG DC LEVEL)	ABD	
R9713	0234 8310	2.7K	CGW	C20
R9714	0234 8380	5.1K	CGW	C20
R9716	0235 0800	10K, ±2%	CGW	C20
R9717	0235 0560	1K, ±2%	CGW	C20
R9751 & R9752	0234 8380	5.1K	CGW	C20
R9753	0234 7980	110	CGW	C20
R9754	0234 8380	5.1K	CGW	C20
R9755	0235 5810	composition, 47, ¼W	ALB	CB
R9756	0234 8380	5.1K	CGW	C20
R9757 & R9758	0234 8210	1K	CGW	C20
R9759	0234 8610	47K	CGW	C20
R9760	0235 5810	composition, 47, ¼W	ALB	CB
R9761	0234 7910	56	CGW	C20
R9763	0234 8310	2.7K	CGW	C20
R9764	0234 8380	5.1K	CGW	C20
R9765	0235 0610	1.6K, ±2%	CGW	C20
R9766	0203 0170	composition, 51	ALB	EB
R9801 & R9802	0227 8290	wire wound, 200	DAL	RS5
R9803	0234 8260	1.6K	CGW	C20
R9804	0234 8090	330	CGW	C20

SWITCHES

Symbol	Part Number	Description	Recommended Vendor Code
S910	0501 7171	rotary, 3 sections, 10 positions (VOLTS/DIV)	ABD
S911	0501 7541	rotary, 2 sections, 12 positions (Input Selector)	ABD
S920 (part of R9226)	0107 2841	SPST	OAK
S921	0501 7601	rotary	ABD
S922	0501 7551	rotary (NORM INVERT)	ABD
S930	0501 7171	rotary, 3 sections, 10 positions (VOLTS/DIV)	ABD
S931	0501 7541	rotary, 2 sections, 12 positions (Input Selector)	ABD
S940 (part of R9426)	0107 2841	SPST	OAK
S941	0501 7601	rotary	ABD
S942	0501 7551	rotary (NORM INVERT)	ABD
S942	0501 7181	rotary (NORM INVERT)	ABD
S960	0501 7163	rotary, 2 sections, 5 positions (MODE)	ABD
S970 (part of S960)	0501 7162	rotary, 1 section, 2 positions (TRIGGER)	ABD

ELECTRON TUBES

Symbol	Part Number	Description	Recommended Vendor Code	Type
V921 & V922	2501 4060	8056	RCA	Nuvistor
V941 & V942	2501 4060	8056	RCA	Nuvistor

NETWORKS

Symbol	Part Number	Description	Recommended Vendor Code
Z9501 & Z9502	8800 2337	peaking	ABD
Z9503 & Z9504	8800 2339	peaking	ABD

CABLE

Symbol	Part Number	Description	Recommended Vendor Code
—	5028 8574	6-inch cable, interconnecting CH2 OUT to CH 1 IN	ABD

SECTION 6B
SPARE PARTS LIST

SPARE PARTS REQUIREMENTS

a. General

The Type 76-08 Dual Trace Plug-in is an extremely reliable and dependable instrument. Only components thoroughly tested and approved by the engineers of the Quality Assurance Department are used in this instrument. Continued performance tests, environmental and life testing of production units make certain your oscilloscope will give many years of satisfactory service. These new Fairchild oscilloscopes are precision-engineered and require no selected parts.

Two lists of "running spares" are included to aid you in periodic maintenance. The running-spare parts lists include recommended quantities and reference symbol numbers. Section 6A of this Instruction Manual gives a complete listing of all components and their recommended vendors so that you may readily procure them from a local supply house or your own stores.

Note: The local Fairchild Scientific Instrument Field Engineering representative and his service organization can assist you in obtaining any additional components in the shortest possible time. To help expedite service, always give the Type Number and Serial Number of the instrument; always specify the part number and give a description of the component. (See Section 6A of this manual.)

b. 500-Hour Spares (6 months)

The recommended list for one through three units is given below.

ELECTRON TUBES

Type	Quantity
V921	2

TRANSISTORS

Q9201	2
Q9203	4
Q9500	4
Q9503	2
Q9505	1
Q9507	1
Q9509	1
Q9511	1
Q9601	2

c. 2000-Hour Spares (2 years)

The recommended list for one through five units is given below. Maintain spares indicated plus one for each oscilloscope in use; 2 of each set of the 500-hour spare list given in paragraph (b) plus the quantities listed as follows:

CAPACITORS

Symbol	Quantity	Symbol	Quantity
C9101	1	C9501	1
C9102	5	C9502	1
C9106	6	C9504	2
C9107	1	C9514	1
C9109	1	C9515	1
C9112	1	C9521	1
C9114	1		
C9122	1	C9602	1
C9124	1	C9603	1
C9125	1	C9652	1
C9126	1	C9656	1
		C9661	1
C9201	1	C9662	1
C9202	15	C9663	1
C9205	1	C9701	1
C9209	1	C9756	1
C9210	1	C9757	1
C9211	1	C9758	1

SEMICONDUCTORS

Symbol	Quantity
CR9201 (FD841)	5
CR9701 (1N728)	1

LAMPS

Symbol	Quantity
DS9201	1
DS9501	1

HEATER ELEMENT

Symbol	Quantity
HY9201	5

ELECTRICAL CONNECTORS

Symbol	Quantity
J9101	1
P9001	1

COILS

Symbol	Quantity
L9501	1
L9801	1

TRANSISTORS

Symbol	Quantity
R9101	3
R9102	1
R9103	1
R9104	1
R9105	1
R9106	1
R9107	1
R9108	1
R9109	1
R9111	1
R9112	1
R9113	2
R9114	1
R9115	1
R9116	1
R9117	1
R9118	1
R9119	1
R9121	1
R9201	1
R9202	1
R9203	1
R9204	1
R9206	1
R9207	2
R9208	4
R9209	1
R9212	2
R9214	1
R9216	2
R9218	2
R9221	1
R9222	2
R9224	1
R9226	1
R9227	1
R9228	3
R9230	1
R9231	4
R9232	3
R9233	1
R9235	1
R9236	2
R9238	1
R9239	1
R9240	1
R9241	1
R9433	1
R9501	1
R9505	1
R9506	1
R9508	1
R9509	1
R9512	3
R9514	1
R9516	1
R9518	1
R9519	1
R9522	1
R9524	1
R9525	1
R9526	1
R9527	1
R9529	1
R9530	1
R9531	1
R9533	1
R9534	1
R9535	1
R9538	1
R9542	1
R9543	1
R9544	1
R9547	1
R9549	1
R9550	1
R9951	1
R9552	1
R9553	1
R9554	1
R9602	1
R9606	2
R9608	1
R9610	1
R9615	1
R9620	1
R9652	1
R9654	2
R9658	1
R9659	1
R9668	1
R9669	1
R9671	1
R9674	1
R9676	1
R9677	1
R9678	1
R9703	1
R9707	2
R9709	1
R9711	1
R9750	1
R9801	1
R9681	1
R9682	1
R9683	1
R9684	1

SWITCHES

Stock only one for each of the following switches for each 10 units being maintained:

S910, S911, S922, S960, S921

NETWORKS

Symbol	Quantity
Z9501	1
Z9503	1

d. Miscellaneous

The following items may be stocked in the quantities of one for each 10 units being maintained:

Name	Function	Part Number
Bushing, shaft	(Gain Adj)	4301 3581
Connector, BNC	(1 Meg, 23 pf)	0905 9940
Fastener, adjustable pawl	—	6401 7390
Guide, plug-in	—	5200 8941
Knob, GP 32	(Volts/Div)	4500 8945
Knob, fastener	—	4501 0431
Knob, small, orange	(Variable)	4501 2021
Knob, small, black	(Selector)	4501 2022
Knob	(Mode)	4501 2035
Knob	(Trigger)	4501 2091
Knob	(Position)	4501 2272
Panel, Front	—	3201 4081

e. Summary

The quantities of spare parts given in the preceding paragraphs are intended for industrial and military duty under normal environment and heavy-use conditions. It is suggested that the maintenance engineer evaluate:

1. The conditions under which the instruments will be used.
2. The skill of the maintenance technicians.
3. Other similar items on hand.
4. The effect of procurement time of spares and effects of instrument down-time on your organization.

It is recommended that inventories of spare parts outlined above be adjusted accordingly to the requirements of your own laboratory or plant.

In the first analysis, the factory recommends the availability of spares or standby equipments since extensive life testing of your instrument has shown no higher failure rate for any specific component.

LIST OF RECOMMENDED VENDORS

CODE	NAME
ABD	Du Mont Laboratories
AER	Aerovox Corporation
AHH	Arrow-Hart & Hegeman Electric Company
ALB	Allen-Bradley Company
ALC	Allied Control
ALCO	Alco Electronic Products
ALD	Alden Products Company
AMA	Amaton Electronic Hardware
AMP	Amp Inc.
AMR	Amperite Company, Inc.
AMX	Amperex Electronics Products, Inc.
APC	American Phenolic Corporation
APH	Amphenol Electronics Corporation
ARC	Arco Electronics Inc. (Elmenco)
AST	Astron Corporation
AUT	Automatic Metal Products Corporation
BNS	Bourns Inc.
BUR	Burndy Engrg. Company
BUS	Bussmann Mfg. Company
CAN	Cannon Electric Company
CBS	CBS-Hytron Division of CBS
CDE	Cornell-Dubilier Electric Corporation
CGW	Corning Glass Works
CH	Cutler-Hammer, Inc.
CHC	Chester Cable Corporation
CHM	Chatham Electronics
CIN	Cinch Manufacturing Company
CLS	Clarostat Mfg. Co., Inc.
COC	Continental Carbon (Division of Wirt Company)
COW	Continental-Wirt Electronics Corporation
CPC	C. P. Clare & Company
CRL	Centralab, Division of Globe-Union, Inc.
CST	Chicago Standard Transformer Corporation
CTC	Cambridge Thermionic Corporation
CTS	Chicago Telephone Supply Corporation
DAG	Dage Electric Company, Inc.
DAL	Dale Products, Inc.
DLC	Dialight Corporation
DRK	Drake Mfg. Company
EBY	Hugh H. Eby, Inc.
EDL	Edal Industries
EIA	Any manufacturer meeting EIA standards
ELC	Electra Manufacturing Company
ELD	Eldema Corporation
ELM	Elmenco
EMC	Electro Motive Mfg. Company
EMW	Elmwood Sensors, Inc.
ERC	Erie Technological Products, Inc.
ESX	Essex Electronics
FCI	Fairchild Camera and Instrument Corporation
FER	Ferroxcube Corporation of America
GDE	Good-All Electric Mfg. Company
GE	General Electric Company
GEN	General Instrument Corporation
GEP	General Products Corporation
GRC	General Radio Company
GRY	Grayhill, Inc.
GUD	The Gudeman Company
HAM	The Hammarlund Manufacturing Co. Inc.
HON	Honeywell
HOP	Hopkins Engineering Company

CODE	NAME
HP	Hewlett-Packard Company
IRC	International Resistance Company
IRP	International Rectifier Corporation
ITT	International Telephone and Telegraph Corporation
JEF	Jeffers Electronics, Inc.
JHN	E. F. Johnson Company
JWM	J. W. Miller Company
KUL	Kulka Electric Mfg. Co. Inc.
KXM	Klixon Metals and Control Corporation
LED	Ledex Inc.
LEE	Leecraft Mfg. Company
LIN	Line Electric
LFI	Littlefuse, Inc.
MAL	P. R. Mallory & Company, Inc.
MCR	Micro Switch (Division of Minneapolis-Honeywell Regulator Co.)
MIC	Micamold Electronics Mfg. Corporation
MIL	Miller Electric Company
MOV	M-O Valve Company Ltd.
MOT	Motorola Semiconductor Products, Inc.
MUC	Mucon Corporation
MUL	Mullard Limited
MUT	The Muter Company
NYT	New York Transformer Company, Inc.
OAK	Oak Mfg. Company
PHC	Philco Corporation
PHI	Philips Electronic Tube Division
PLS	Plastoid Corporation
POT	Potter & Brumfield, Inc.
PRC	Precision Resistor Co., Inc.
PYR	Pyramid Electric Company
RCA	Radio Corporation of America
RMC	Radio Materials Corporation
ROY	Royal Electric Corporation, Inc.
RTN	Rotron Mfg. Company
SIG	Signalite Inc.
SIL	Silicon Transistor Corporation
SLT	Sealectro Corporation
SOL	Solitron Devices, Inc.
SPG	Sprague Electric Company
STC	Stackpole Carbon Company
STW	Standard Winding Company
SUM	Summit Coil Company
SWT	Switchcraft Inc.
SWW	Stanwyck Winding Company
SYL	Sylvania Electric Products, Inc.
SYN	Syntronic Instruments, Inc.
TEC	Transistor Electronics Corporation
TEX	Texas Instruments, Inc.
THC	Thermal Control, Inc.
TOR	Torrington Mfg., Company
TRS	Tresco, Inc.
TRU	Tru-Ohm Products
TUG	Tung-Sol Electric Inc.
UCN	Ucinite Company
UTC	United Transformer Company
VIC	The Victoreen Instrument Company
WDE	Wood Electric Corporation
WDL	Ward Leonard Electric Company
WES	Weston Electrical Instrument Corporation
WYN	Welwyn International Inc.

INSTRUMENT WARRANTY AND SERVICE NOTICE

WARRANTY

The Instrumentation Division warrants that each new Cathode-ray Oscilloscope, Automotive Test Equipment, and other Electronic or Electrical Test or Measuring Equipment (hereinafter referred to as "Instrument") manufactured or sold by it, is free from defects in material or workmanship under normal use and service for a period of one year from the date of its sale to the first purchaser for use. If, upon examination by Fairchild, the Instrument is determined to be defective in workmanship or material, Fairchild will, subject to the conditions set forth below, either repair the defective part or replace it with a new part. Fairchild shall not be liable for any delay or failure to furnish a replacement part resulting directly or indirectly from any governmental restriction, priority or allocation or any other governmental regulatory order or action, nor shall Fairchild be liable for damages by reason of the failure of the Instrument to perform properly or for any consequential damages. This warranty does not apply to any Instrument that has been subject to negligence, accident, misuse or improper installation or operation or that in any way has been tampered with, altered or repaired by any person other than an authorized Fairchild service organization or an employee thereof, or to any Instrument whose serial number has been altered, defaced or removed, or to any Instrument purchased within, and thereafter removed beyond, the continental limits of the United States.

This warranty shall, at Fairchild's option, become void unless registration thereof is promptly effected as provided below. This warranty is in lieu of all other warranties, expressed or implied, and no one is authorized to assume any liability on behalf of Fairchild or impose any obligation upon it in connection with the sale of any Instrument, other than as stated above.

REGISTERING THE WARRANTY

To register this warranty, the enclosed warranty registration card must be properly filled out and mailed to the Instrument Service Department immediately upon receipt of the equipment. Complete information is necessary. BOTH THE TYPE NUMBER AND THE SERIAL NUMBER OF THE INSTRUMENT MUST BE GIVEN ON THIS CARD. Instruments must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

CHANGES IN SPECIFICATIONS

The right is reserved to change the published specifications of equipment at any time and to furnish merchandise in accordance with current specifications without incurring any liability to modify equipment previously sold, or to supply new equipment in accordance with earlier specifications excepting under the classification of special apparatus.

SERVICE

In order to insure service under our warranty, the enclosed warranty service card must be properly filled out and returned to the factory. In all cases where service or adjustment is requested, please first contact the factory or authorized depot, giving complete information concerning the nature of the failure and describing the manner in which the equipment was used when failure occurred. THE TYPE NUMBER AND SERIAL NUMBER of the equipment must also be given. In this way, much time can be saved and unnecessary inconvenience often avoided. When writing to the factory in this respect, address:

Fairchild Camera and Instrument Corp.
Instrumentation Division
50 Somerset Place, Clifton, New Jersey

The Instrument Service Department will then send to the customer the written procedure for disposition and shipping instructions. All equipment should be packed and shipped in accordance with this procedure; and identification tags should be attached to each tube or instrument.

REPLACEMENT PARTS

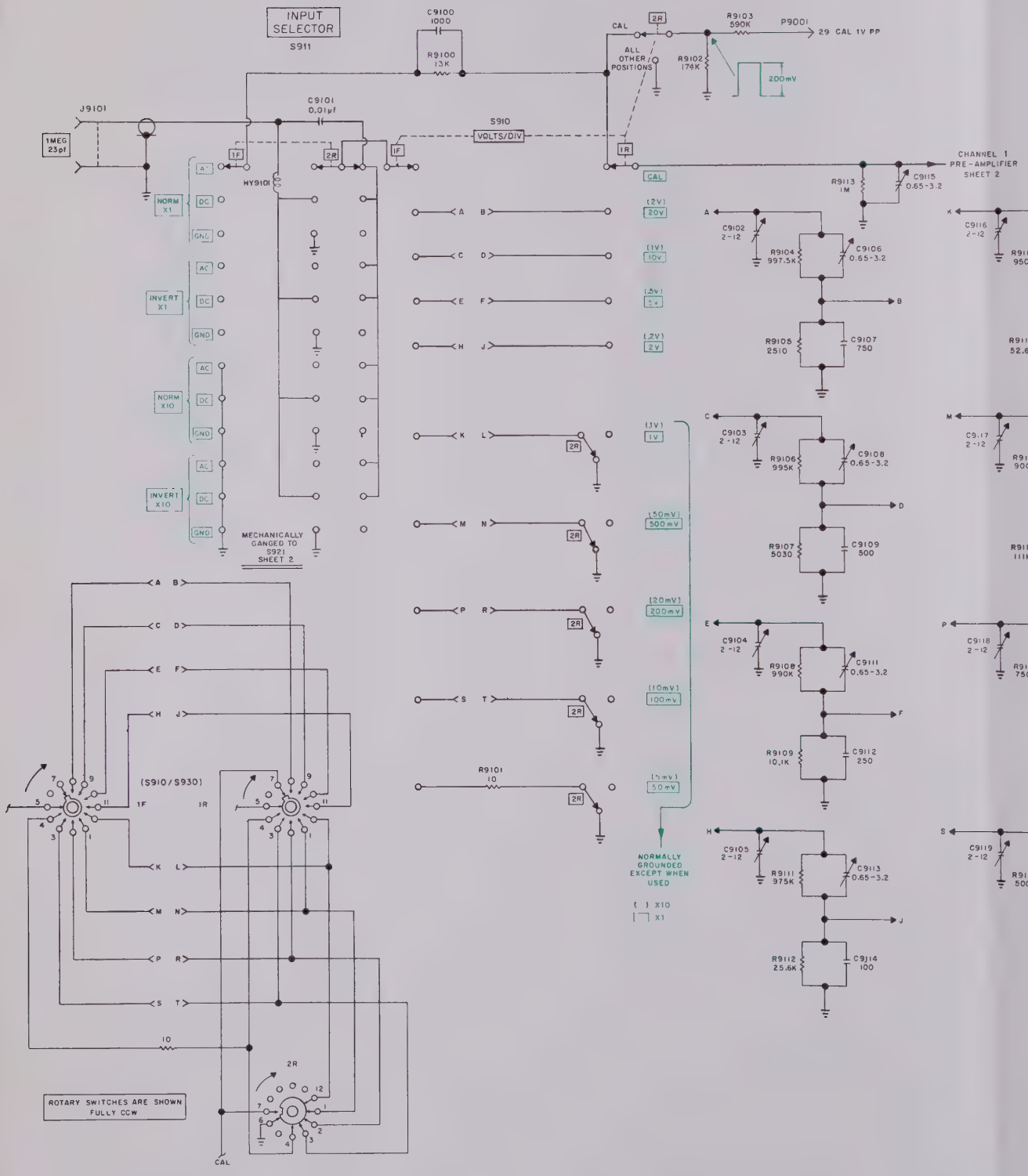
If it is necessary to order a replacement component from the factory, always give the Type number and Serial number of the Instrument. Before ordering parts for in-warranty replacement or purchasing them for out-of-warranty replacement, be sure to consult the Parts List in the Instruction Manual. The Parts List gives the values, tolerances, ratings, and Fairchild part number for all electrical components used in the Instrument. This will help to expedite service.

PATENT NOTICE

Manufactured under one or more U. S. Patents owned or controlled by Fairchild Camera and Instrument Corporation. 50 Somerset Place, Clifton, New Jersey, U.S.A. Patent Numbers supplied upon request.

IMPORTANT—FILL OUT AND MAIL THIS CARD NO STAMP REQUIRED
WARRANTY REGISTRATION
EQUIPMENT PURCHASED BY
SEE INSTRUCTION MANUAL FOR WARRANTY NOTICE
MAIL FIELD MAINTENANCE BULLETINS
VOID UNLESS MAILED WITHIN 30 DAYS AFTER RECEIPT

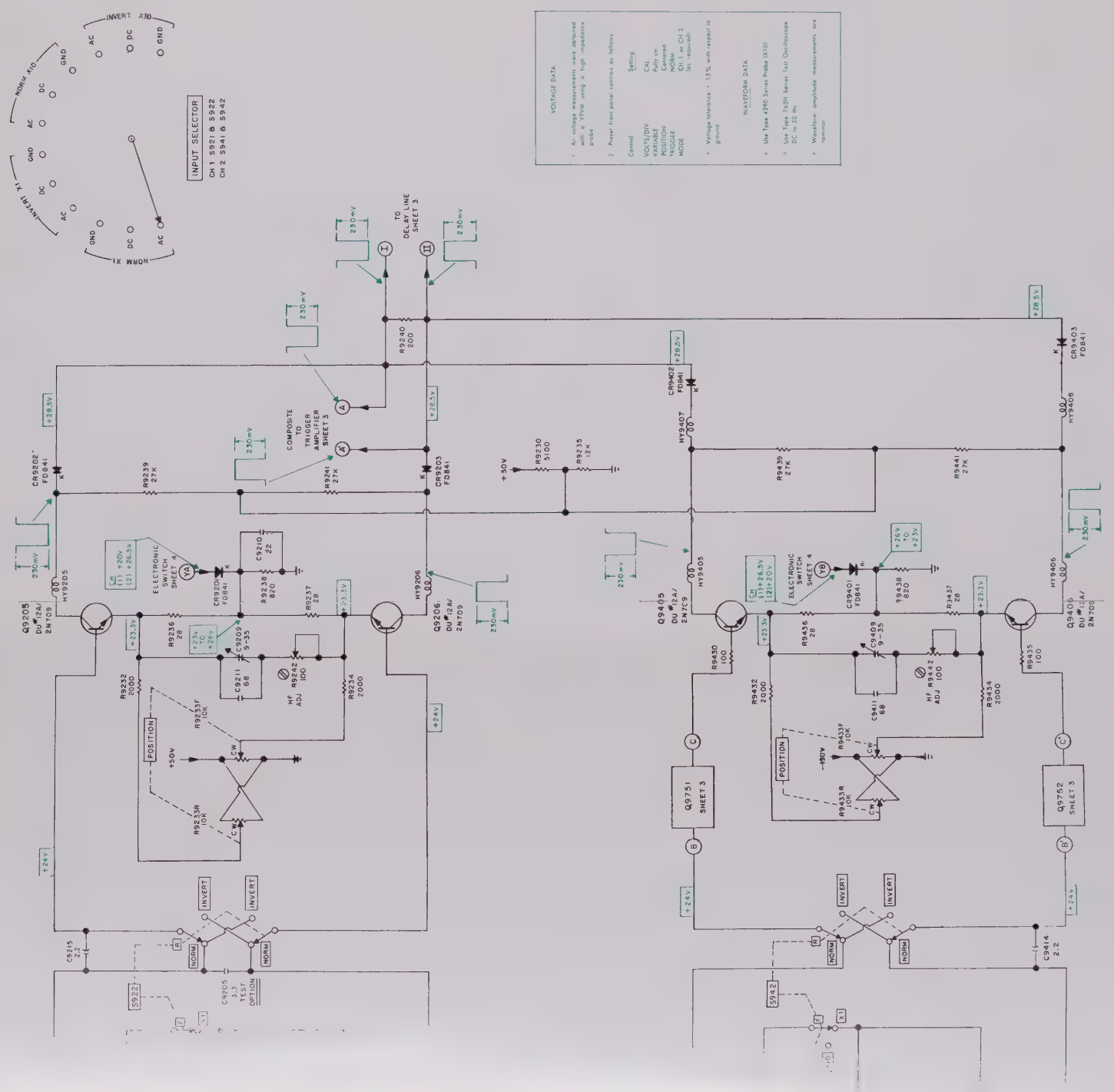
CHANNEL 1 ATTENUATORS

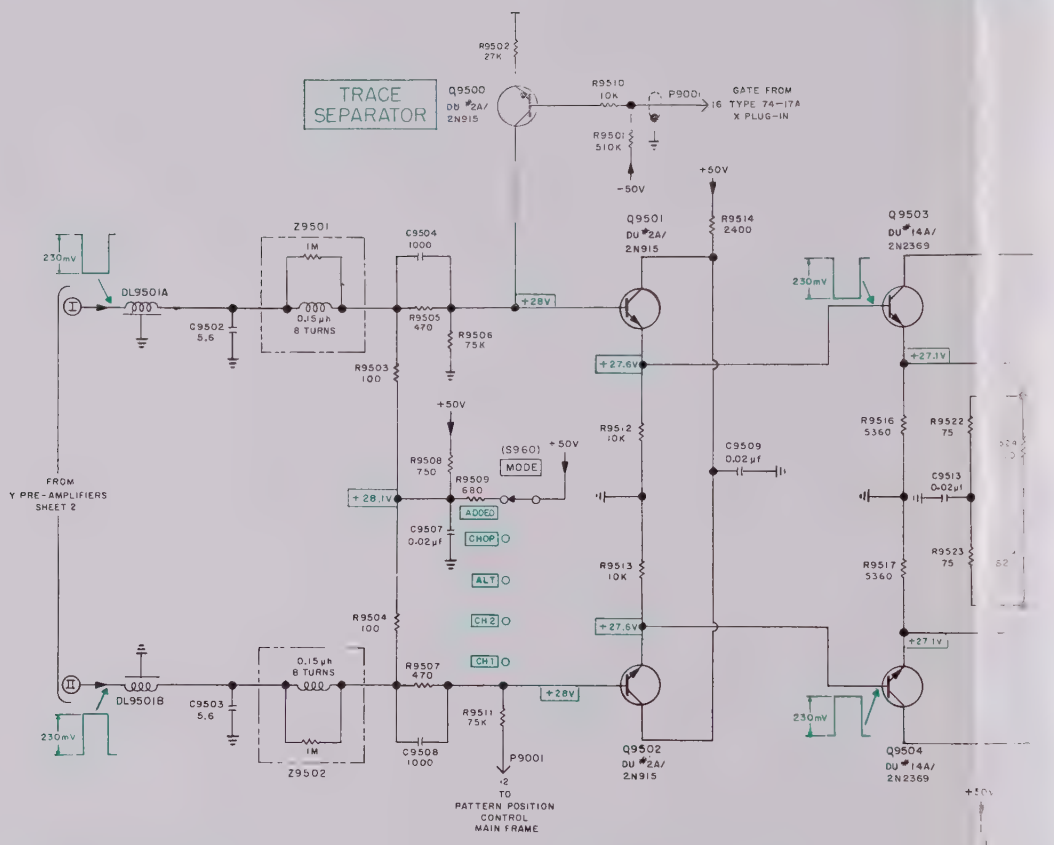


NOTES

1 RESISTANCE VALUES ARE IN OHMS, K=THOUSAND, M=MILLION

2 CAPACITANCE VALUES ARE IN pf UNLESS OTHERWISE SPECIFIED


INPUT SELECTOR
CH 1 S921 & S922
CH 2 S941 & S942
VOLTAGE DATA
1. All voltage measurements were obtained with a VTVM using a high impedance probe.
2. Preset front panel controls as follows:
Control — Setting
VOLTS/DIV — CAL
VARIABLE — Fully cw
POSITION — Centered
TRIGGER MODE — Normal
CH 1 or CH 2 (as required)
1. Voltage tolerance ± 15%, with respect to ground.
WAVEFORM DATA
4. Use Type 2990 Series Probe (X10)
5. Use Type 7634 Series Test Oscilloscope DC to 50 Mc.
7. Waveform amplitude measurements are nominal.
TO DELAY LINE SHEET 3
COMPOSITE TO TRIGGER AMPLIFIER SHEET 3
ELECTRONIC SWITCH SHEET 4
Q9205 DU*12A/2N709
Q9206 DU*12A/2N709
Q9405 DU*12A/2N709
Q9406 DU*12A/2N709
Q9751 SHEET 3
Q9752 SHEET 3
POSITION
HF ADJ
INVERT
NORM
TEST OPTION
S922
S942



VOLTAGE DATA

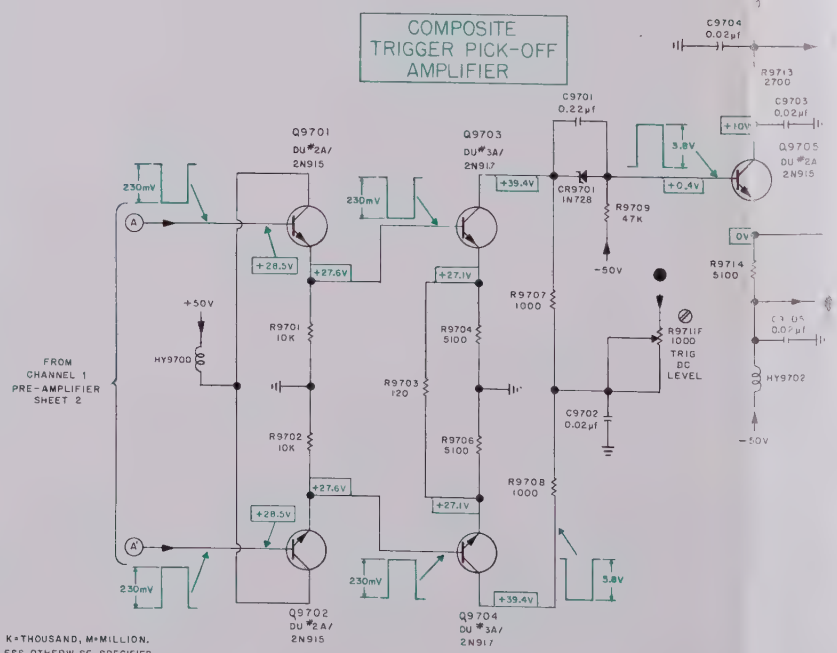
1. All voltage measurements were obtained with a VTVM using a high impedance probe.
2. Preset front-panel controls as follows:

Control	Setting
VOLTS/DIV	CAL
VARIABLE	Fully cw
POSITION	Centered
TRIGGER	NORM
MODE	CH 1 or CH 2 (as required)

3. Voltage tolerance ±5% with respect to ground.

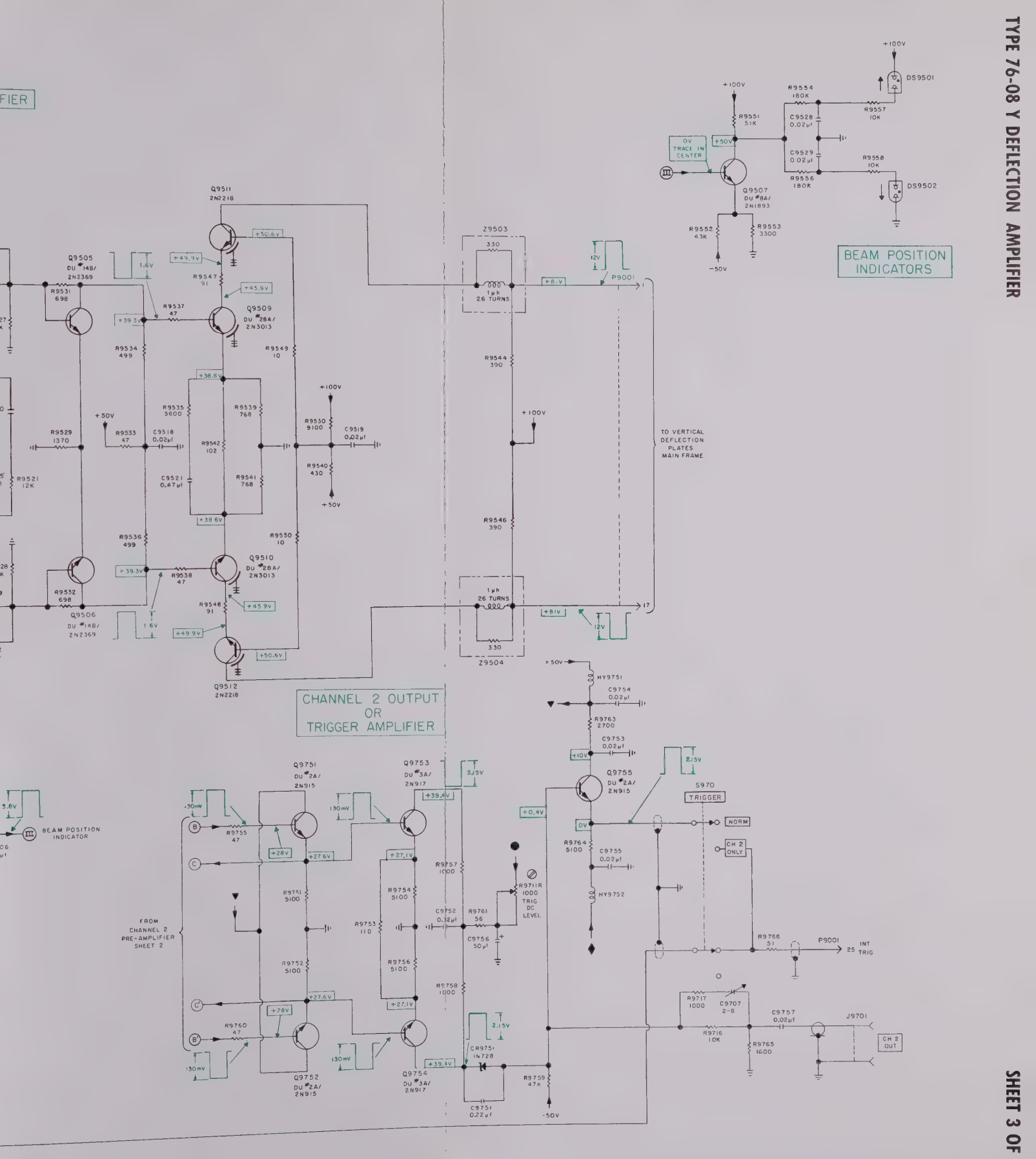
WAVEFORM DATA

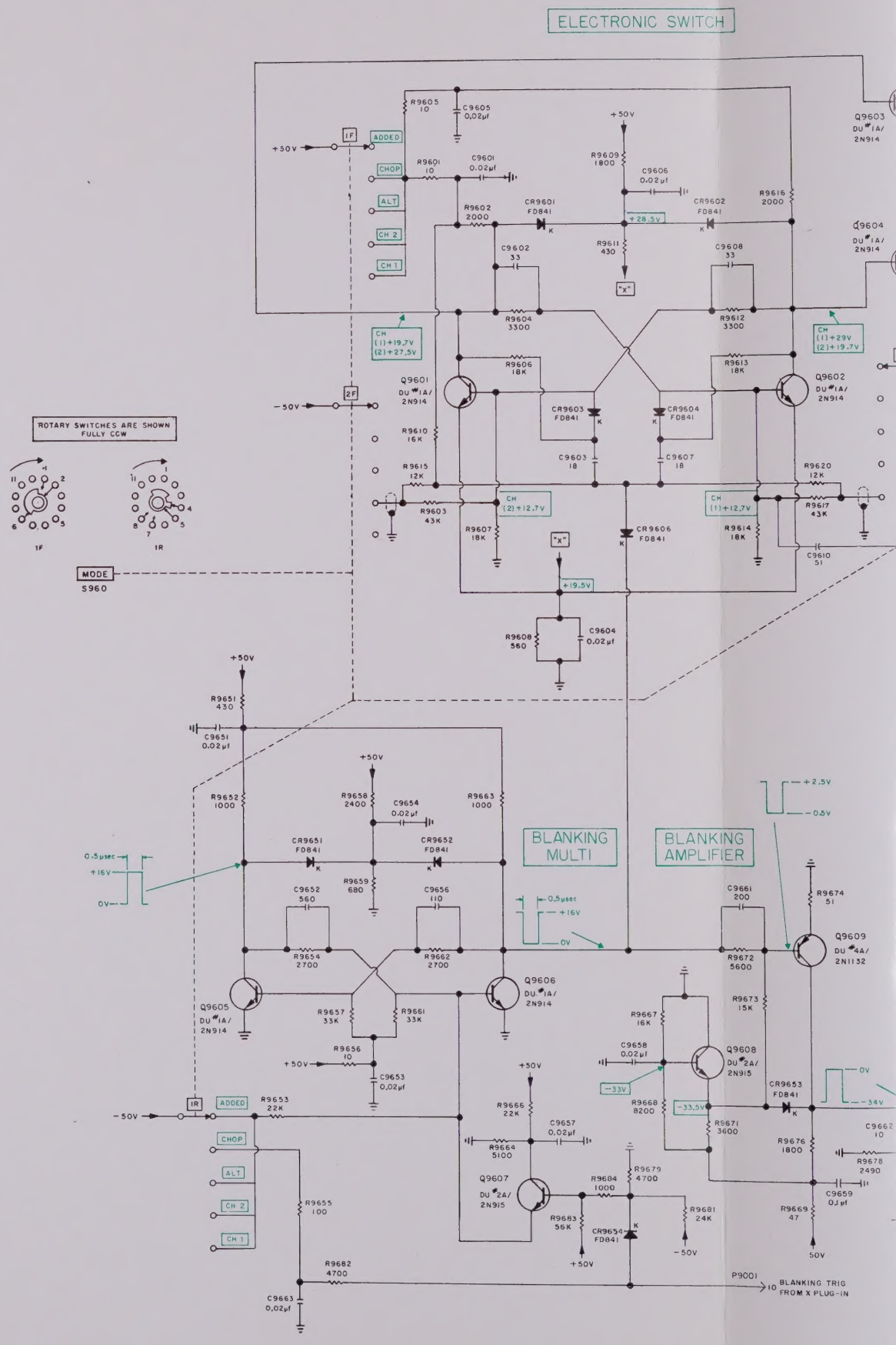
4. Use Type 4290 Series Probe (X10).
5. Use Type 765H Series Test Oscilloscope DC to 50 Mc.
6. Waveform amplitude measurements are nominal.

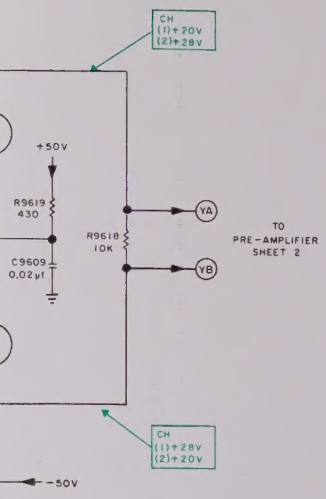


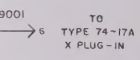
NOTES

1. RESISTANCE VALUES ARE IN OHMS, K=THOUSAND, M=MILLION.
2. CAPACITANCE VALUES ARE IN pf UNLESS OTHERWISE SPECIFIED.
3. ⊘ SERVICE ADJUSTMENT.
4. ●, ▼, ◆, COMMON TIE POINTS.
5. HEAT SINK.


FIER
+100V
DS9501
R9554 180K
R9557 10K
C9528 0.02µf
C9529 0.02µf
R9558 10K
R9556 180K
DS9502
R9551 51K
+50V
0V TRACE IN CENTER
Q9507 DU *8A/ 2N1893
R9552 43K
R9553 3300
-50V
BEAM POSITION INDICATORS
Q9511 2N2218
Q9505 DU *14B/ 2N2369
+50.6V
+49.9V
1.6V
R9547 91
+45.9V
R9531 698
R9537 47
+39.3V
Q9509 DU *28A/ 2N3013
R9534 499
R9549 10
+38.6V
Z9503
330
1µh 26 TURNS
12V
P9001
+8.1V
R9544 390
+100V
R9535 3600
R9539 768
R9530 9100
C9519 0.02µf
+50V
R9529 1370
R9533 47
C9518 0.02µf
R9542 102
R9540 430
C9521 0.47µf
R9541 768
R9521 12K
+38.6V
R9546 390
TO VERTICAL DEFLECTION PLATES MAIN FRAME
R9536 499
R9550 10
Q9510 DU *28A/ 2N3013
+39.3V
R9538 47
R9532 698
R9548 91
+45.9V
Q9506 DU *14B/ 2N2369
1.6V
+49.9V
+50.6V
Q9512 2N2218
1µh 26 TURNS
+8.1V
12V
17
330
Z9504
CHANNEL 2 OUTPUT OR TRIGGER AMPLIFIER
+50V
HY9751
C9754 0.02µf
R9763 2700
C9753 0.02µf
+10V
2.5V
Q9755 DU *2A/ 2N915
S970
TRIGGER
+0.4V
0V
NORM
CH 2 ONLY
R9764 5100
C9755 0.02µf
HY9752
Q9751 DU *2A/ 2N915
Q9753 DU *3A/ 2N917
2.5V
130mV
+39.6V
B
C
R9755 47
+28V
+27.6V
+27.1V
R9757 1000
R9754 5100
R9751 5100
R9753 110
C9752 0.12µf
R9761 56
R9711R 1000 TRIG DC LEVEL
C9756 50µf
FROM CHANNEL 2 PRE-AMPLIFIER SHEET 2
R9752 5100
R9756 5100
R9758 1000
R9766 51
P9001
25
INT TRIG
R9717 1000
C9707 2-8
R9716 10K
C9757 0.02µf
J9701
CH 2 OUT
R9765 1600
R9760 47
Q9752 DU *2A/ 2N915
Q9754 DU *3A/ 2N917
2.15V
CR9751 1N728
C9751 0.22µf
R9759 47K
-50V
BEAM POSITION INDICATOR


ELECTRONIC SWITCH
ROTARY SWITCHES ARE SHOWN FULLY CCW
1F
1R
MODE
S960
ADDED
CHOP
ALT
CH 2
CH 1
+50V
-50V
+28.5V
+19.5V
"X"
R9605 10
C9605 0.02µf
R9601 10
C9601 0.02µf
R9602 2000
CR9601 FD841
R9609 1800
C9606 0.02µf
CR9602 FD841
R9616 2000
R9611 430
C9602 33
C9608 33
R9604 3300
R9612 3300
Q9603 DU*1A/ 2N914
Q9604 DU*1A/ 2N914
CH (1)+19.7V (2)+27.5V
CH (1)+29V (2)+19.7V
R9606 18K
R9613 18K
Q9601 DU*1A/ 2N914
Q9602 DU*1A/ 2N914
CR9603 FD841
CR9604 FD841
R9610 16K
C9603 18
C9607 18
R9615 12K
R9620 12K
R9603 43K
R9617 43K
CH (2)+12.7V
CH (1)+12.7V
R9607 18K
CR9606 FD841
R9614 18K
C9610 51
R9608 560
C9604 0.02µf
R9651 430
C9651 0.02µf
R9652 1000
R9658 2400
C9654 0.02µf
R9663 1000
CR9651 FD841
CR9652 FD841
R9659 680
C9652 560
C9656 110
R9654 2700
R9662 2700
BLANKING MULTI
BLANKING AMPLIFIER
0.5µsec
+16V
0V
+2.5V
-0.5V
R9674 51
C9661 200
R9672 5600
Q9609 DU*4A/ 2N1132
Q9605 DU*1A/ 2N914
Q9606 DU*1A/ 2N914
R9657 33K
R9661 33K
R9656 10
C9653 0.02µf
R9667 16K
C9658 0.02µf
Q9608 DU*2A/ 2N915
R9673 15K
-33V
R9668 8200
-33.5V
CR9653 FD841
R9671 3600
-34V
R9676 1800
C9662 10
R9678 2490
C9659 0.1µf
R9669 47
50V
IR
R9653 22K
R9666 22K
C9657 0.02µf
R9664 5100
Q9607 DU*2A/ 2N915
R9679 4700
R9684 1000
R9683 56K
CR9654 FD841
R9681 24K
R9655 100
R9682 4700
C9663 0.02µf
P9001
10 BLANKING TRIG FROM X PLUG-IN





VOLTAGE DATA

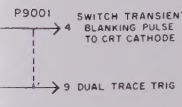
1. All voltage measurements were obtained with a VTVM using a high impedance probe.
2. Preset front-panel controls as follows:

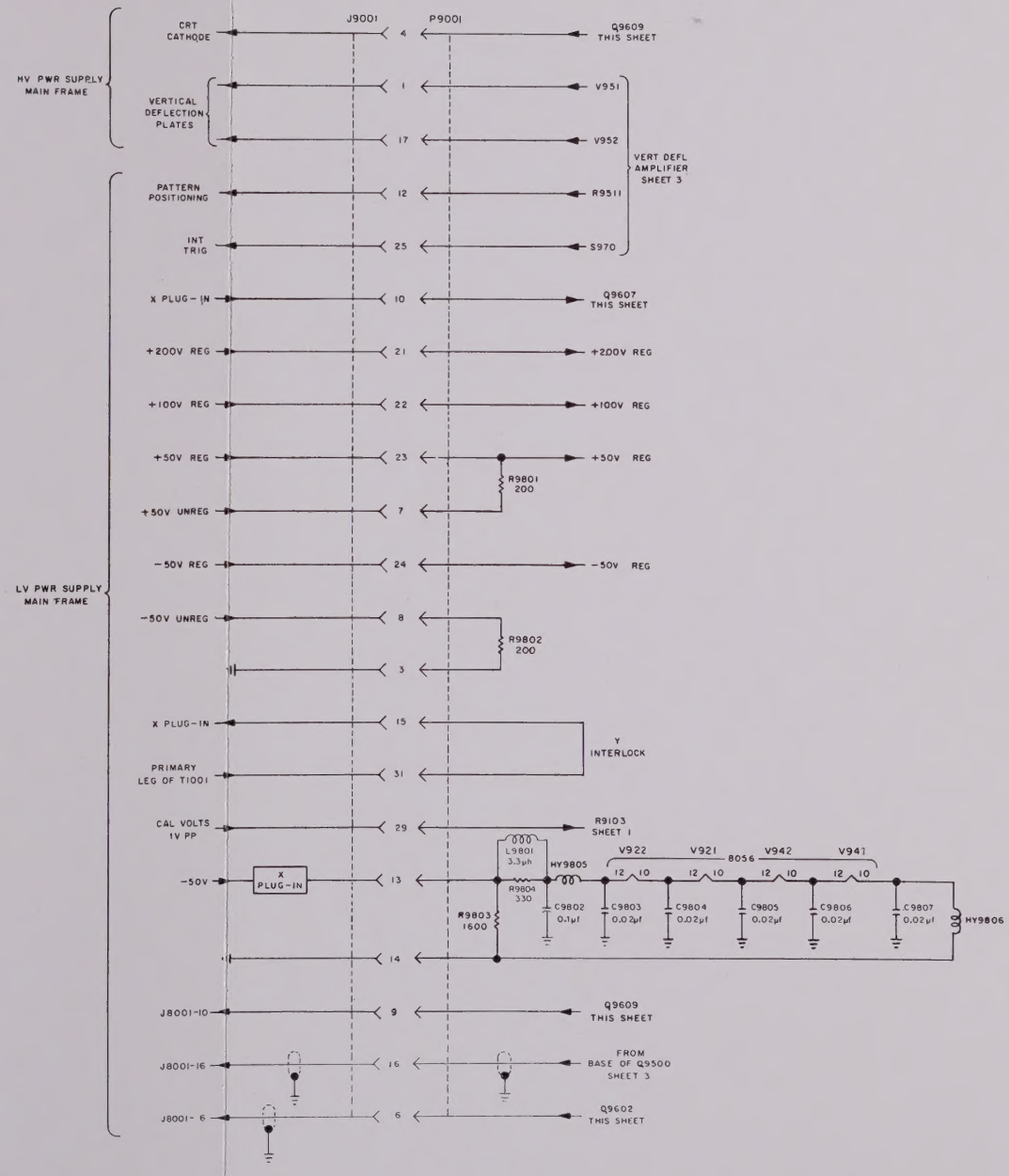
Control	Setting
VOLTS/DIV	CAL
VARIABLE	Fully cw
POSITION	Centered
TRIGGER	NORM
MODE	CH 1 or CH 2 (as required)

3. Voltage tolerance ± 15% with respect to ground.

WAVEFORM DATA

4. Use Type 4290 Series Probe (X10).
5. Use Type 765H Series Test Oscilloscope; DC to 50 Mc.
6. Waveform amplitude measurements are nominal.





NOTES:
1. RESISTANCE VALUES ARE IN OHMS, K=THOUSAND, M=MILLION.
2. CAPACITANCE VALUES ARE IN pf UNLESS OTHERWISE SPECIFIED.

DUMONT
OSCILLOSCOPE LABORATORIES, INC.